Report of the . . . .

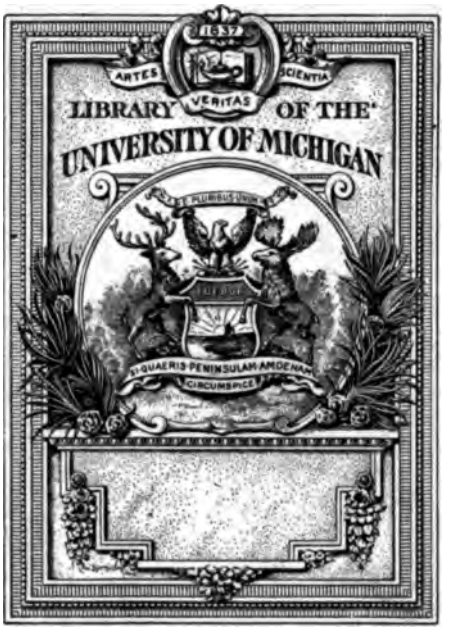
South African

Association for the

Advancement of

Science.

Natal 1907



REPORT

OF THE

SOUTH AFRICAN ~~ASSOCIATION~~ journal of science

FOR THE

ADVANCEMENT OF SCIENCE.

FIFTH MEETING,

NATAL, 1907.

CAPE TOWN AND JOHANNESBURG:
PUBLISHED BY THE ASSOCIATION.
1908.

Cape Town :
THE ARGUS PRINTING AND PUBLISHING COMPANY, LIMITED.

1908.

EDITORIAL NOTE.

The editorial committee regret that they have been compelled to reduce so many contributions to an abstract or a mere title. The reason for this will become sufficiently clear on examining the report of the Hon. Treasurer, on page xvii. ; and the committee can only hope that their somewhat drastic action will enable the Association to do more justice next year, to the scientific work turned out by South Africa.

Johannesburg, May, 1908.

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SECTION D.

SECTIONS E and F.

OFFICE BEARERS AND MEMBERS OF COUNCIL FOR 1907-8.

The following are the office bearers and members of Council for the year 1907-8 :—

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B. H. DODD, M.A.
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Rev. CHARLES PETTMAN.
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MINUTES OF FIFTH ANNUAL GENERAL MEETING OF MEMBERS, HELD AT DURBAN, ON TUESDAY, THE 16TH JULY, 1907.

Dr. James Hyslop presided, and there were also present:—Dr. J. Moir, Messrs. R. T. A. Innes, H. J. Burroughs, A. Dickie, F. G. Katzenstein, Dr. J. McCrae, Messrs. A. S. Langley, William Lucas, Rev. J. FitzHenry, Mr. W. E. C. Clarke, Miss M. J. S. Clarke, Mrs. Innes, Miss Killick, Messrs. J. W. McLaren, H. B. Austin, E. Nevill, Dr. R. A. Lehfeldt, Messrs. G. S. Bishop, J. A. Foote, Miss A. Frankenstein, Messrs. C. W. Methven, J. D. Stevens, Col. H. E. Rawson, Messrs. B. Siegheim, G. W. Herdman, J. F. Cadenhead, Professor J. Orr, Dr. C. Potts, Messrs. A. Read, Jas. Gray, Rev. T. G. Vyvyan, Prof. G. H. Stanley, Messrs. A. Struben, E. Williams, Col. Watkins-Pitchford, Mr. W. H. Helmore, Mrs. L. R. Helmore.

The report of the Council for the period 13 July, 1906, to 16 July, 1907, was read and adopted.

The Treasurer's Report and statement for the year ending 30th June, 1907, was adopted.

The names of Members elected by the different Centres as representatives on the Council for the year 1907-08, were submitted to the Meeting, and their election was unanimously confirmed, as follows:

Bulawayo.

Franklin White, M.I.M.M.

Cape Peninsula.

H.E. The Hon. Sir Walter Hely-Hutchinson, G.C.M.G.
Prof. J. C. Beattie, D.Sc., F.R.S.E.
Prof. L. Crawford, M.A., D.Sc., F.R.S.E.
Rev. W. Flint, D.D.
R. Marloth, M.A., Ph.D.
J. M. P. Muirhead, F.S.A.A., F.C.I.S., F.S.S., F.R.S.L.
Albert Walsh,

Kimberley.

Arnold H. Watkins, M.D., M.R.C.S.
Alpheus F. Williams.

King William's Town.

H. M. Chute, M.R.C.S., L.R.C.P.

Port Elizabeth.

Thos Reeve.
(Wm. Arnott since elected *vice* Thos Reeve resigned).

Queenstown.

Thomas Findlay Tannahill, M.D., C.M., D.P.H.

Salisbury.

Guy A. K. Marshall, F.Z.S., F.E.S.
(Lt.-Colonel R. Chester-Master since elected *vice* G. A. K. Marshall resigned.)

East London.

Geo. Rattray, M.A., B.Sc., F.R.G.S.

Grahamstown.

S. Schönland, M.A., Ph.D., F.L.S., C.M.Z.S.
Prof. J. E. Duerden, M.Sc., Ph.D., A.R.C.S.

Pietermaritzburg.

J. W. Shores, C.M.G., M.I.C.E.
Lt.-Col. H. Watkins-Pitchford, F.R.C.V.S.

Potchefstroom.

T. Wedgewood Lowden.

Witwatersrand.

S. J. Jennings, M.Am.I.M.E.
A. Aiken, F.S.A.A.
A. von Dessauer, M.E.
F. Flowers, F.R.G.S.
G. Murray, M.B., F.R.C.S., L.R.C.P.
R. T. A. Innes, F.R.A.S.
J. Moir, D.Sc., M.A., F.C.S.
J. Moir.
E. Williams, M.I.M.M.
Dr. J. McCrae.
W. Windham.
R. B. Young, M.A., B.Sc., F.R.S.E.
J. R. K. Barker.
Prof R. A. Lehfeldt, D.Sc., B.A.
Prof. J. Orr, B.Sc.

Durban.

C. W. Methven, M.I.C.E.
A. Mackenzie, M.D., C.M., M.R.C.S.

Bloemfontein.

Hugh Gunn.
Geo. Potts, Ph.D.

Pretoria.

H. D. Badcock, M.A., M.I.C.E., F.R.A.S.
G. V. Herdman, M.A., M.I.C.E.
C. D. Braine, A.M.I.C.E.
J. Burtt-Davy, F.L.S., F.R.G.S.
A. M. A. Struben, A.M.I.C.E.

It was unanimously resolved to accept the invitation to hold the Annual Meeting next year in Grahamstown.

The following votes of thanks were unanimously carried :—

To the Mayor and Mayoress (Mr. and Mrs. A. W. Kershaw) and Councillors of the Borough of Pietermaritzburg, for their kindness and hospitality.

To the Mayor and Mayoress (Mr. and Mrs. C. Henwood), and Councillors of the Borough of Durban, for their kind hospitality.

To the Superintendent of Education, Mr. C. J. Mudie, for the use of the schools for the work of the Association, in both Pietermaritzburg and Durban.

To the Chairmen and Committees of the Victoria and Durban Clubs, for extending to visiting members the privilege of honorary membership.

To the Durban Corporation, particularly the Mayor, and Mr. Fletcher, the Town Engineer, for the visit to the Waterworks.

To Mr. A. M. Neilson, of the S.A.F. Co. Works; the Manager, Natal Match Factory; and to the Hon. Marshall Campbell, M.L.C., for the Mount Edgecombe visit.

To the several South African Railway Administrations, for the travelling facilities granted to members.

To Dr. J. D. F. Gilchrist and Mr. Wm. Cullen, the Honorary General Secretaries; and to Mr. Howard Pim, the Honorary General Treasurer; and to Mr. M. Maclachlan, the Honorary Auditor to the Association.

During the regrettable illness of Mr. Cullen, Dr. J. Moir has very kindly undertaken the duties of Honorary Secretary, and Mr. W. G. Morton the duties of Honorary Treasurer during Mr. Pim's absence from South Africa. The hearty thanks of the Association are due to these two gentlemen, for so kindly filling the breach. To the Press of Pietermaritzburg and Durban for the excellent manner in which the proceedings of this meeting were reported. On the motion of Mr. Struben, a hearty vote of thanks was accorded to Dr. Hyslop.

The Meeting then closed.

Report of the Council for the Period from 13th July, 1906, to 16th July, 1907.

The report of the Treasurer for the year ended 30th June, 1907, with financial statements, is appended :—

From this it will be noted that there is a debit balance of £231 14s. 5d. This must be considered a most unsatisfactory state of affairs, and is due largely to the non-payment of arrear subscriptions. Members in arrear with their subscriptions are therefore earnestly requested to make every effort to pay the practically nominal amount, the non-payment of which places the Association in an unnecessary straitened position. The outstanding subscriptions on 30th June, 1907, amounted to about £500, and the Council had, with regret, to enforce the rule dealing with members whose subscriptions are in arrear for three or more years, thereby removing from the register the names of eighty-three members.

Reports re Grants.—The Council has received reports from the following to whom grants in aid of research were made :—

a. Mr. J. Stuart Thompson on the Alcyonaria of Cape Colony and Natal.

b. Prof. J. C. Beattie on Earth Magnetism in South Africa.

c. Dr. J. D. F. Gilchrist on the Investigation of the Fresh Water Fishes of South Africa.

d. Dr. A. W. Roberts on Astronomy.

e. Dr. J. E. Duerden on Tortoises.

No further report has been received from Mr. J. Burtt-Davy with regard to the progress of his work on an " Annotated Catalogue of the Flowering Plants and Ferns of the Transvaal." This is presumably owing to Mr. Burtt-Davy's absence from South Africa.

Standing Committees on Education and Anthropology were formed in November, 1905. The Educational Committee has presented a report for this meeting which has been read before Section E. and F. A new Anthropological Committee has been constituted to which the sum of £10 has already been voted, and this becomes payable during the current year.

Rules with regard to grants have been framed by the Council, and are appended :—

Sargant Prize.—The Council has awarded the Sargant prize of £25 to the Rev. H. A. Junod for an essay on " The Best Means of Preserving the Traditions and Customs of the Various South African Native Races." The essay by Dr. H. Lyster Jameson, entitled " An Ethnographic Bureau for South Africa," was also very highly commended by the adjudicators. Both the foregoing essays are printed in this volume.

S.A. Medal Fund.—The Council has framed rules for the constitution of a Medal Committee, and the procedure to be adopted in making the award. (See appendix).

Local Branches of the Association.—The Council has approved of the principle of the formation of active branches to continue the work of the Association in the intervals between the annual sessions, and has formulated provisional rules for their guidance. These rules are subject to such modification as the Council may eventually decide on in view of suggestions to be received from the various centres.

Revision of Sections.—As already announced, the Council has slightly revised the arrangement of the sections in order to obtain a more scientific distribution of the subjects dealt with.

Lectures.—A series of lectures on English literature by Prof. Walter Raleigh, of Oxford, has been arranged by the Johannesburg Members of the Council, in furtherance of which the Witwatersrand Council of Education has made a grant of £500. It is hoped that these lectures will give a stimulus to general culture in South Africa.

1908 Meeting.—An invitation has been received for the Association to hold its next annual meeting in Grahamstown, which invitation your Council has gratefully accepted. The date of the meeting will be announced as soon as possible.

Report of the Acting Honorary Treasurer for the Year ending 30th June, 1907.

I beg to submit the following report on the Financial position of the Association, together with a Statement of Accounts for the year ending the 30th June, 1907.

The wave of depression which is at present sweeping over the Country, has seriously affected the finances of the Association, a state of affairs which it is hoped will prove of a temporary nature.

The Membership of the Association as given in the last year's report was 1,322, and of these only 614—less than half—have paid their subscriptions for the year under review, a state of things which is greatly to be regretted. Every endeavour has been made by your Secretaries to recover the amounts outstanding, without meeting with better success than that shown in the Revenue account.

The Receipts from all sources have been £724 0s. 6d.—the expenditure £1,148 14s. 8d. The main items in the latter amount are £622 17s. 4d. for the printing of the Report of the Kimberley Meeting, £200 of which was kindly contributed by De Beers' Consolidated Mines, £170 for grants, and £135 18s. 1d., the balance of the cost of the Kimberley Meeting and the preliminary expenses of this present Meeting. The general expenditure of the Association has been carefully controlled during the past year, and shows a reduction of nearly £200 as against last year's expenditure.

Turning to the Balance Sheet, you will notice that, deducting the amount to the credit of the British Association Volumes, which is really a matter apart from the Association, there is at your credit at the Bank, £374 3s. 10d. Against this amount the Association has debts to meet amounting to £573 8s. 3d.; £30 has to be invested under your rules, and £31 really has to go to your next year's account. It is for your members to see that these amounts are paid, and one can only trust they will endeavour to get these Members whose subscriptions are in arrears to meet their obligations, and to also secure further paying Members. It will therefore be seen that the Association cannot incur any fresh liabilities for printing the Report of the Natal Meeting, or make any fresh grants for research unless substantial support is forthcoming. There is really no reason why, if Members would only pay their subscriptions, for the enlistment of outside help, but that resource must be enlisted if the Members are so remiss in this matter.

The amount of the endowment fund has been increased from £819, as in the last accounts, to £893. Of this amount £863 has been placed on Fixed Deposit by your Trustees at Cape Town, at 4½ per cent. interest per annum.

During the year 83 Members have resigned and 160 have been struck off the Roll for non-payment of subscriptions, death, or removal, while 53 have been elected, making your present Membership 1,032. 23 Associates have been enrolled.

Wm. D. Morton.
Acting Hon. Treasurer.

SOUTH AFRICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

BALANCE SHEET: 30TH JUNE, 1907.

ASSETS.							LIABILITIES.						
By Investment of Endowment Fund Account: Amount invested (Fixed Deposit, Capetown, @ 4¼ %)				£863	0	0	To Subscriptions paid in advance ...			£31	0	0
„ Office Furniture: Cape Town and Johannesburg				28	10	0	„ Sundry Creditors: (including £422 17s 4d for Kimberley Report, and £100 for Grants ...			573	8	3
„ Cash at Bank: Cape Town ...	£127	7	8				„ Subscriptions and Government Grant paid for Sets of B.A. Volumes	£956	13	6		
„ „ Johannesburg ...	294	2	7				Less Printing and Editorial Expenses	909	7	1		
				421	10	3					47	6	5
„ Revenue Account: Balance from Revenue Account, June 30, 1907	424	14	2				„ Endowment Fund A/c.: Balance 30th June, 1906	819	0	0		
Less Balance at June 30, 1906 ...	192	19	9				„ Received to 30th June, 1907, Entrance Fees	64	0	0		
				231	14	5	„ Received to 30th June, 1907, Life Members' Subscriptions ...	10	0	0		
											893	0	0
				£1,544	14	8					£1,544	14	8

W. D. MORTON, Acting Hon. Treasurer.

I have examined the above Balance Sheet, compared the same with the Books and Vouchers, and hereby certify that it correctly sets forth the position of the Association as at 30th June, 1907, as shown by the books.

Johannesburg, July, 1907. M. W. MACLACHLAN, C.A., { Hon. Auditor.

SOUTH AFRICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

REVENUE ACCOUNT FOR THE YEAR ENDING 30TH JUNE, 1907.

REVENUE.						EXPENDITURE.					
By Annual Subscriptions received, 1906-7	£614	0	0			To General Expenses (postages, wires, telephone and sundries) ...	£98	8	6		
,, Arrears	40	0	0			,, Printing and Stationery... ...	40	9	9		
,, Associate Fees: Kimberley Meeting	24	15	0			,, Salaries and Bonuses	265	0	0		
,, Associate Fees: Natal Meeting...	9	15	0			,, Branch Expense	6	11	0		
				£688	10 0	,, Depreciation on Furniture ...	9	10	0		
,, Interest on Fixed Deposit ...				29	15 0					£419	19 3
,, Sales of Proceedings, Vols. 1 & 2				5	15 6	,, Expenses: Kimberley Meeting, (balance)	94	5	4		
,, Balance: Excess of Expenditure over Revenue				424	14 2	,, Expenses: Natal Meeting, (preliminary)	41	12	9		
										135	18 1
						,, Grants for Research				170	0 0
						,, Proceedings, Vol. 3, Kimberley Report. Total Cost of printing and postages	622	17	4		
						Less donation by De Beers Co.	200	0	0		
										422	17 4
				£1,148	14 8					£1,148	14 8

Johannesburg, July, 1907.

Audited and found correct,

M. W. MACLACHLAN, C.A., { Hon. Auditor.

OFFICERS OF SECTIONAL COMMITTEES.

NATAL, JULY, 1907.

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J. R. WILLIAMS (1904).
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E. W. BARNS, M.A.
Prof. J. C. BEATTIE, D.Sc, F.R.S.E.
F. FLOWERS, F.R.A.S., F.R.G.S.
S. S. HOUGH, F.R.S.
R. T. A. INNES, F.R.A.S.
Prof. R. A. LEHFELDT, D.Sc., B.A.
JAS. LYLE, M.A.
Col. H. R. RAWSON, C.B., R.E.

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Sir P. E. GIROUARD, (1904).
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J. MOIR, D.Sc., M.A.
Prof. J. ORR, B.Sc., A.M.Inst.C.E.
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R. G. KIRKBY, A.R.I.B.A., M.R.S.I. | WALLACE PATON.

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H. WATKINS PITCHFORD, F.R.C.V.S.

Vice-Presidents :

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Dr. G. S. CORSTORPHINE, (1904).
Capt. T. QUENTRALL, (1906).
ex-officio.
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J. S. HENKEL.
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PRESIDENT'S ADDRESS.

PRESIDENTIAL ADDRESS

By James Hyslop, D.S.O., M.B., C.M.

I have to thank the Association for having appointed me its President, an honour which I fully appreciate, but which I am at the same time deeply sensible that I have done nothing either in the way of scientific attainments or original research to deserve. I regard my present position, however, more in the light of a compliment to the profession to which I have the honour to belong, a profession, I may remark, at one time largely empirical in its methods, but now daily becoming more and more scientific; and on that account my gratitude is all the greater.

I may well be excused for feeling the greatest diffidence in opening this Annual Congress, when I realise that my predecessors in office—some of whom have made most valuable contributions to science—have been Sir David Gill, Sir Charles Metcalfe, Mr. Reunert, and Mr. Gardner Williams.

The South African Association will always have reason to bear the name of its first President, Sir David Gill, in grateful remembrance, as it is in large measure owing to his efforts that its very existence is due; and I feel sure I am but voicing the sentiment of every member of the Association under whose auspices we are met here to-night, when I offer him our most hearty congratulations on the well-earned honour which the British Association has seen fit to confer on him by electing him as its President for the current year. At the same time I feel assured that those of you who know him best will agree with me that the British Association, in assigning to our original President first place in its illustrious roll of members, and thus paying homage to Sir David Gill, are at the same time honouring themselves.

In these days, when science is making such rapid strides, and scientific discoveries of more or less importance are of such frequent occurrence, it would be futile for me, even had I the temerity to do so, to attempt to touch on the different subjects—twenty-three in number—which will hereafter engage our attention at the sectional meetings; but if I may be permitted to crave your indulgence for a short time, I will avail myself of the privilege usually accorded to a general President, of not confining myself to one scientific subject, or even to subjects strictly scientific in their nature, in endeavouring to lay before you a few illustrations of what science has already done, and may yet be expected to accomplish for us.

To those of you who, like myself, have been sufficiently long in South Africa to be classed as old Colonists, the marvellous improvements which the application of science has made possible, not only in the celerity, but also the comfort of the journey between what many of us still call Home and this country, must appeal in the strongest degree; and if we look backwards and picture the hardships with which the earliest voyagers had to contend in essaying to round the "Cape of Storms," the contrast is, of course, infinitely greater. Then it was a question of years, now it is one of days, or at most, of weeks; in addition to which, communication between South Africa, the Homeland, and practically all other portions of the Empire, is of hourly occurrence.

Again, on setting his foot on these once inhospitable shores, the traveller finds that science has not been idle, but on the contrary has been exerting herself to the utmost to anticipate his wants; that at various vantage points of the sea-board, the forces of Nature have been harnessed and used to assist in the accomplishment of what, even in the memory of some of us, were regarded as almost insurmountable engineering difficulties; and perhaps there is no more striking illustration of the statement I have just made than at the Port of Durban, where, thanks in a large measure to the scientific genius of one of our Sectional Presidents (Mr. Cathcart W. Methven) and his persistent adherence to scientific principles as applied to marine engineering, what was a comparatively short time ago a sand-locked—or perhaps I should say a bar-locked—bay, has been converted into a magnificent harbour, accessible at all times to even the largest ocean leviathans. Needless to say, but for the application by Mr. Methven and those associated with him of the principles I have mentioned, and the carrying out under his directions of the works connected therewith in the face of strong and persistent opposition, this gateway to the interior would still practically have been shut to us, and what is perhaps of no less moment to us locally, the present condition and the future prospects of this small, but I venture to think not altogether negligible portion of South Africa, would have been vastly different to what they are to-day. Nor has the energy displayed by the engineer been confined to the sea-board, but the comforts of the traveller and the requirements of commerce have been equally met, almost to the northern confines of British South Africa—a condition of affairs which has been rendered possible by the wise prescience and wonderful persistence of that grand Imperialist and greatest of South African statesmen who sleeps his last sleep in the centre of that space dedicated as sacred to those who have deserved well of their country, and guarded by the giant boulders of his beloved Matoppos. That the iron bands, already far on their way, will yet connect Cape Town with Cairo, penetrating regions known to Europeans in the not distant past only through the writings of explorers such as Livingstone, Speke, Grant and Stanley; thus realising the predictions of that great dreamer, but at the same time intensely practical statesman, Cecil John Rhodes, will, I think, not be doubted by any.

The scientist has also brought his technical knowledge to bear in many other directions. It is inconceivable but for him that the Witwatersrand district, practically uninhabited a few years ago, could have become the centre of South African commercial and industrial activity it is to-day, and the same applies to most of the larger South African industries; and we have, further, every reason to believe that future developments will make still greater demands on the resources of science.

But while it may serve the passing hour to win from the earth its treasures of precious stones, gold, and the various minerals, still, that in itself can after all lead only to temporary prosperity. It is consequently gratifying to find that those placed in authority, and thus responsible in a large measure for the direction of affairs, have, more particularly of late, been urging on us the desirability, if not the absolute necessity, of more attention being given in the future to the cultivation of the soil. I think I am right in saying that the High Commissioner, Lord Selborne, rarely misses an opportunity of emphasising the importance of the matter, and that he is supported in his views by all the South African Governors, and by not a few of their Ministers, among whom certainly not the least enthusiastic is the present Prime Minister of Natal, the Right Hon. Frederick Moor, who returned only the other day, fresh from the Conference of Colonial Premiers, preaching in season and out of season the gospel of production as the most potent panacea for the commercial depression at present overshadowing the whole of South Africa.

Our late Governor also, Sir Henry McCallum, in distributing the prizes at the Maritzburg College some months ago, very strongly advocated more attention being directed to agricultural pursuits, and the placing of the most talented boys of the family on the land, and directed attention to the fact that in the past the land had been neglected at the expense of the professions, under the most erroneous idea that anyone, be he ever so dull, was good enough for a farmer. Sir Henry very properly pointed out the fallacy of such an assumption, and the inevitable result which such a procedure was bound to lead to. Let us hope that this, not the least of his many wise and thoughtful utterances, will not be allowed to pass unheeded.

It has been stated that he who makes two blades of grass grow where one grew previously is a benefactor to humanity, and I believe I have seen the opinion expressed that the soil of South Africa contains more wealth within six inches of its surface than all the gold already won, or ever likely to be recovered from the Johannesburg mines. However this may be, I think we may fairly assume that the South African Governments are fully alive to the potentialities of the soil, and that this is evidenced by the provision made by its Agricultural Departments, and the means furnished through these Departments for instructing the farmer in scientific methods, by which means alone the best results will be obtained.

I noticed only the other day that a vacation course of lectures had been arranged for farmers and those interested in such pursuits,

under the auspices of the Rhodes University at Grahamstown, which, I take it, may be regarded as a sign of the times; but we need go no further for evidence of the awakened interest in this industry than the Natal Agricultural College and Experimental Farm at Cedara, which it is hoped some of the members will be able to visit, and where, though the College course has only run for one session, there have been more applications from prospective students than the authorities are able to entertain.

The primary object of this Association is the Advancement of Science, and the scientist forms no exception to the general rule, that the earlier he takes up his work, the more likely he is to succeed. According to an oft-quoted statement by Professor Huxley, "No boy should be allowed to leave school without possessing a grasp of the general character of science, and without having been disciplined, more or less, in the *methods* of science." At the time Huxley tendered this advice, it was probably more needed, in at least so far as this country is concerned, than it is to-day. Here, while there is doubtless room for improvement, the importance of a scientific training is recognised to an extent such as has never hitherto been done, and thanks to the foresight of our progressive and enlightened Education Departments, and to private enterprise, many of our schools and colleges are furnished with the most up-to-date equipment for the teaching of science, the appliances in the chemical, physical, and other laboratories, leaving little to be desired. Excellent museums, so necessary for the teaching of science, are also now to be found in the principal centres of population throughout South Africa.

In this connexion, may I be permitted to digress for a moment to pay a tribute to the great scientist and teacher I have just mentioned. I should like to do so the more, that I had the privilege of sitting under Professor Huxley, while he temporarily filled the chair of Natural History in the University of Edinburgh, during the absence of Sir Wyville Thompson on the "Challenger" Expedition; and although I have to confess that while Huxley's students may have acquired from him little knowledge of a kind which would enable them to successfully meet the ordinary examiner—more especially if the examiner confined himself to what might be called book-knowledge—no one could listen to, or come under the influence of that truly great man, without being captivated by the ineffable charm of his manner, or becoming lost in admiration at the clear, earnest and convincing way in which he dealt with his subject; and, while recognising in him a brilliant investigator, a lucid expositor, and a fearless critic, what after the lapse of years perhaps stands out most clearly in one's memory, is the importance which, as he was never tired of impressing on us, should be attached to the scientific attitude of mind (of which his own was perhaps one of the most conspicuous examples), and his commendation of "that enthusiasm for truth, that fanaticism of veracity, which is a greater possession than much learning, a nobler gift than the power of increasing knowledge."

If I may still trespass on your patience with a further personal reminiscence, I should like to make reference to another member of the professioriate of the University of Edinburgh, contemporary with Huxley. I refer to Lord Lister, who, while I had the good fortune to be his pupil, was deeply immersed in the problem of antiseptic surgery, and whose researches in that direction have done more for the science of surgery, and the saving of life by surgical treatment, than any previous discovery. As has been well said, Lister's scientific work, and the consequent adoption of his antiseptic methods (though, as I well remember, they were very much scoffed at by some of his colleagues), have rightly been admitted not only to have laid the foundation, but also to have reared the superstructure of modern surgery, with the result that, by the adoption of his methods, operations are to-day undertaken with impunity, which before his time would not have been dreamt of. Lister may, in fact, be regarded as one of the most signal benefactors of suffering humanity, and were it at all necessary to adduce evidence in support of the statement, the following (from a speech by Mr. Bayard at the Royal Society) might be quoted, when in addressing Lord Lister, he said: "My Lord, it is not a profession, it is not a nation, it is humanity itself, which with uncovered head salutes you." To show what humanity is saved, as a result of Lister's labours and discoveries in the domain of antisepticism, I quote from an address delivered by Sir Frederick Treves, before the Edinburgh Philosophical Institution, in which he depicts what takes place in a septic wound, or a wound allowed to become septic through disregard of antiseptic precautions.

"Let us suppose that a wound has been sustained, and that certain germs or micro-organisms have been introduced thereto. These germs, finding themselves in a favourable soil, proceed to flourish and multiply. They multiply in no uncertain number. Those who are curious in the matter of birth-rates may be interested to know that the progeny of one single cell may, at the end of twenty-four hours, be 16 millions. They are not only prolific, but they produce a subtle poison called a toxin. The invasion, therefore, of the body by a poison-producing host, capable of multiplying by millions in a day, is a matter of some concern. Now, how is this germ-invasion met? There is a rush of blood to the wounded part, the vessels around the damaged area enlarge to their utmost capacity, in order that as much blood as possible may be brought to the invaded quarter. Blood is hurried to the part for precisely the same reason that an army is hurried to the frontier when a country is attacked. At the seat of the wound an invading force has landed; their weapon is poison; they need neither transport, auxiliaries, nor stores, for they live on the body itself, and can add to their numbers without extraneous aid. The blood, on the other hand, contains certain cells or corpuscles, poor, pale, flabby-looking objects called leucocytes, which are, however, born microbe-killers, and have a passion for fighting which no racial hatred among men could even faintly imitate.

These leucocytes do not wait for the invading germs to enter the blood vessels, but make their way out of these channels to meet the invaders in the open. They also have the power of multiplication, and in the field are joined by comrades of the same kind. There now takes place a battle the like of which no pen has ever attempted to describe. Millions are opposed to millions, and the fighting is to the death. The hosts of Armageddon would be a mere handful to the uncountable hordes which fill the battle-field about the confines of a wound. The leucocytes destroy the germs by eating them—they also, by sacrificing their living bodies to the poison of the enemy, save the country they defend. The mortality of this conflict is beyond the limits of reasonable computation. The arena is piled up with the dead, until at last, the living, the dead, the poisoners and the poisoned, are thrown out in the form of what is known as 'matter' or 'pus,' and the trouble probably ends."

The terrible carnage so graphically described by Treves is Nature's way of dealing with a hostile intruder in her territory. It is the province of antisepticism to prevent, so to speak, the landing of the enemy, in which case the country will remain at peace, and the encounters in defence of it, as described by Sir Frederick Treves, will be uncalled for; but, in the event of a landing being effected, the fight put up in defence of the territory will, in a certain number of cases, be successful. In many instances, however, it will not, and in not a few the inhabitants will either be annihilated or the country left in a crippled condition. All this loss and disturbance it is the province of antisepticism to avoid.

While we have noted what vast strides have been made in the domain of antiseptic surgery, there are still not a few ailments which, although it is hoped they may yet be successfully dealt with, have up to the present completely baffled the resources of science; among the most dreaded of these is perhaps cancer, investigations as to the nature and cause of which are, thanks in a large measure to the interest taken in the matter by His Majesty the King, being prosecuted in a manner never attempted heretofore. The principal investigations, in so far as the British Empire is concerned, are being conducted under the auspices of the Imperial Cancer Research Fund in the Central Laboratory, placed at the disposal of the Fund by the Royal College of Physicians and Surgeons; and the various Colonies and Dependencies are contributing their quota towards the work, in the way of general information, reports on cases, and the supply of specimens of diseased tissue; and are otherwise rendering as much assistance as possible through the Colonial and Indian Offices. When, if ever, a remedy will be found, it is impossible to say, but the prospects, I believe, are at present far from hopeless.

The National Association for the Prevention of Consumption and other forms of Tuberculosis is actively engaged in its campaign against that fell disease, which, despite Professor Koch's pronouncement at Berlin some 17 years ago, to which I was privileged to listen, unfortunately still continues its ravages, although, as you are

aware, much, very much, can be done in the way of preventing its spread. The Americans, ever quick at putting into practice what they are convinced is for the good of their country, have long ago set us an example in preventive legislation, and, what is even more to the point, have put that legislation into force. We, I fear, have been slow to follow their excellent example, but at present there are not wanting signs of our awakening. The question of an active campaign against the disease in South Africa was brought up by my friend Dr. Ramsbottom at the South African Medical Congress held here some two years ago. The various South African Governments have been communicated with, and an endeavour is being made to interest the public in the matter, particularly by means of public meetings in the large towns.

A Royal Commission has been considering the matter at Home, and its findings go to confirm the idea that one of the chief agencies for the spread of the disease is through the medium of milk. Dr. Stanley, in this connexion, urges the sterilization of milk as one of the most efficient safeguards against its spread, and caustically remarks: "We pay far more attention to the purity of beer, which, even when absolutely pure, slays millions, than of the purity of milk, which, when impure, slays hundreds of thousands."

Doubtless it will be a long time before an easy-going public can be got to interest itself to any appreciable degree in such matters, more especially as the evil is one which they cannot see, or easily understand. All the more necessary, therefore, is it to invoke the assistance of a scientific society such as ours in a matter fraught with the most momentous consequences to the race.

A very interesting and important investigation is at present being conducted by Dr. Ford-Robertson, Pathologist to the Scottish Asylums. In 1903 he advanced the hypothesis that the specific etiological factor in General Paralysis—the one outstanding incurable form of mental disease—is a diphtheroid bacillus, and, in a paper read before the Medico-Psychological Association in May last (not yet published), he mentioned having isolated two varieties of diphtheroid bacilli, capable of producing General Paralysis, viz., what he has called *bacillus paralyticans longus* and *brevis* respectively; also bactericidal sera corresponding to the two varieties of diphtheroid bacilli have been produced and administered as therapeutic agents with the most encouraging results. Should these researches—as there appear to be reasonable grounds for hoping—lead to the successful treatment of General Paralysis of the Insane, his work in this connexion will rank as one of the most remarkable achievements of our time.

Turning to tropical medicine, the scientist has never been so actively engaged in the investigation of diseases incidental to warm climates, as within recent years; as may be instanced by the attention given to such questions at Home, and the establishment of Schools of Tropical Medicine at London and Liverpool. The discoveries made, even within comparatively recent times, have not only been

numerous, but important, including, for instance, the mode by which such diseases as Malaria, Yellow Fever, Plague, and Malta Fever are spread; also the causes of that dread disease, Sleeping Sickness, the no less dreaded Indian scourge "Kala-Hazar," and the more homely, at least in so far as the name is concerned—African Tick Fever.

In connexion with these diseases, various insects, including the mosquito, the bug, and the flea, have attained a prominence in marked contrast to the obscure position they have occupied heretofore. With the information now available, the absolute stamping out in a district of such diseases as Malaria and Yellow Fever, is not only possible, but absolutely certain, depending mainly on two conditions, which, though simple, are unfortunately not always to be met with, viz., the determination to exterminate the cause of the disease, and the financial ability to undertake such measures as are necessary in connexion therewith. In illustration of the efficacy of these measures of extirpation, one has only to point to such places as Ismailia or Port Swettenham, or, nearer home, the Borough of Durban, where war has been waged against the *anopheles* in connexion with Malaria; and Havana and New Orleans, where, as a result of the eradication of the *Stegomyia fasciculata*, or, in American parlance, "the Steg," Yellow Fever has completely disappeared. Many of you will remember the address delivered in this Hall by Colonel Bruce during the visit of the British Association, and the lucid exposition he gave as to the cause of Sleeping Sickness, but no efficient method for its treatment has yet been found, although several expeditions with this particular object in view have been sent out to investigate the matter (the Liverpool School of Tropical Medicine having taken a leading part, largely, I believe, as a result of the munificence of its Chairman, Sir Alfred Lewis Jones).

Dr. Fuller, only the other day, in his presidential address to the members of the Western Division of the Cape of Good Hope branch of the British Medical Association, very warmly advocated the establishment of a medical school for South Africa, and it is hoped that the matter will receive consideration at the hands of the Conference about to be appointed to deal with University matters, as well as by others specially interested in medical education, and that not only will such a school become an accomplished fact, but that not a few South African citizens, who have benefited so largely from a financial standpoint as a result of their residence in the country, following the example of Cecil Rhodes and Alfred Beit, will see that a department connected with the investigation of disease, particularly those peculiar to or prevalent in South Africa, shall be adequately endowed.

It will be generally conceded that one of the first duties of a country is to provide for its defence, and the subject is one which has received a great deal of attention in the Homeland during recent years, the awakened interest in such matters being doubtless due, in a large measure, to recent operations in South Africa having disclosed

certain defects in our military organisation, or at least shewn certain directions in which improvements might be effected.

To us in South Africa, being, as we are, a comparatively small and sparsely scattered white community, living alongside an alien and uncivilised race, which in some districts greatly outnumbers us, the subject is of paramount importance, and consequently I do not feel called upon to offer any excuse for bringing it to your notice, the more so that I am strongly of opinion that it has not received in the past that attention and recognition, from a scientific standpoint, which its undoubted importance would seem to merit.

The Commander, deeply engrossed in placing as many of the enemy as posible *hors de combat*, and at the same time in protecting his own forces from the bullets of his opponents, is apt to forget that there may be a much more deadly peril—disease—lurking in his own lines, and that no effort should be spared in grappling with this danger should it, as it not infrequently does, assail his ranks; or, what is perhaps of far more importance, he should see to it that those who are qualified to do so, are afforded every facility to enable them—as far as possible—to prevent disease obtaining a lodgment therein.

As I have on a former occasion stated from this platform (and the statement will bear repetition), it is an undoubted fact that in protracted campaigns the losses from disease have been infinitely greater than from casualities sustained in action, and although matters have vastly improved in this respect in recent times, the deaths per thousand during the Anglo-Boer War were 69 from disease, as compared with 42 from wounds; or, putting the matter in another light, 450,000 troops were treated in hospital for disease during the war, and 14,800 deaths occurred; while the admissions from wounds received in action were only 22,000 in all; but what is of more interest and importance, from a scientific standpoint, no less than 74,000 cases were admitted to hospital suffering from preventible disease, and 9,200 of these proved fatal.

I have endeavoured to obtain the statistics relating to the Cape Wars of 1877-79, and the Basuto War of 1880-81, but have failed to trace them. In the Bechuanaland Expedition, however, of 1896-97, with a strength of 2,326, I find that 10 deaths occurred as a result of disease, the nature of which, however, is not stated, while 17 were killed, or died as the result of wounds.

It is hardly fair to compare small matters with large, and I trust I may not be considered egotistical in mentioning that during the recent native rebellion in Natal, extending as it did over a period of nine months, and with an approximate average of 2,125 troops on the field—the largest number at any one time being about 6,000 —we had only two deaths from ordinary disease, as against 23 killed, or died from wounds received in action; and not a single death had to be recorded from a preventible disease. I am far from affirming that this undoubtedly satisfactory condition is to be attributed to measures adopted on scientific principles, although the medical officers

in the field were never weary of impressing on all and sundry their vital importance; at the same time, I contend that the adoption of such principles must, theoretically, be followed by results similar to what we have achieved.

According to Mr. St. John Brodrick, "the medical service, of all departments of the Army, excites the acutest criticism during a campaign, and the most meagre public interest in peace"; but thanks to his forethought and that of the present Secretary of State for War (Mr. Haldane) in matters affecting the health and well-being of the troops, and the support given by them to the schemes of the Director-General of the Army Medical Department and his advisers, a new era as regards hygiene and sanitation in the field appears to have set in; and only the other day an order was issued from Headquarters at Pretoria with a view to testing practically the new Field Sanitary Organisation during the Army manœuvres to be held in September next. Let us hope this is an earnest of a new departure in so far as preventive medicine in the field is concerned, and that its vast importance will be fully realised. As has been pointed out, the proper place for the Medical Officer is in the van, rather than the rear of the Army, on the principle that "prevention is better than cure."

When it is realised that every man who becomes sick weakens the fighting strength not only in so far as he himself is concerned, but by those who have to look after him, and that in addition he reduces its mobility, and adds very materially to the expense of its upkeep, it is, I should say absolutely impossible to over-estimate the importance of observing even the most minute details which experience and the teaching of science has shewn to be necessary to cope with disease, more particularly with disease of a preventible nature—which, in a campaign, is the most to be dreaded. A small army well cared for in this respect should be infinitely more powerful than a comparatively large force where the fighting capacity only of the men is considered, and their health neglected.

The question of animal diseases, particulary those peculiar to or more prevalent in South Africa than other countries, has received a good deal of attention of late years, especially at the hands of the bacteriologist. Among the more important of these diseases may be mentioned Horse Sickness, Rinderpest, and African Coast Fever.

Major, now Colonel Joshua Nunn, was sent out to Natal in 1887 to investigate Horse Sickness, and the following scientists have, since then, for varying periods, been engaged by the different South African Governments, principally in the investigation of animal diseases, viz: Colonels Bruce and Watkins-Pitchford, Professors Koch, Danysz and Bordet, and Drs. Theiler, Eddington, Turner, Kolla, Dogson, and others. Some years ago I was Chairman of a Committee appointed by the Natal Government to enquire into and report on certain matters connected with Colonel Pitchford's investigations into Rinderpest, and I take this opportunity of stating that I consider he has not received that recognition which his original scientific work

connected with that disease justly entitles him to. He has for some years been engaged in the investigation of Horse sickness, and has already published his views as to the etiology of the disease and the preventive measures to be adopted in connection with it, and I hardly think we will be disappointed in expecting a considerable addition to our knowledge of the conditions obtaining in that disease, as a result of his recent investigations.

The members of this Association will, I feel sure, unite with me in congratulating Mr. A. W. Rogers, of the Cape Geological Commission, on the recent award made to him of the Bigby Medal by the Geological Society in recognition of his contributions to South African Geology.

We have also to congratulate Mr. Methven on the award made to him by the Institute of Civil Engineers, in recognition of his work and achievements connected with South African Harbours.

This Association received a great impetus as a result of the visit of the British Association a couple of years ago, and the members of the latter Society have, in a very practical manner, shown their appreciation of any little kindness or attention extended to them while with us, by the initiation of a South African Medal Fund raised to commemorate their visit in 1905. The fund, in accordance with the wish of the donors, has been invested in the name of trustees appointed by the South African Association, and the administration of the fund and the award of the medal, "For achievement and promise in scientific research in South Africa," has been entrusted to our Association. It may confidently be hoped that this generous act on the part of the British Association will be the means of stimulating the prosecution of original research in South Africa, and the recipients of the medal will doubtless prize it all the more, seeing it is the gift of the British Association, and that it forms a not inappropriate link between a comparatively old and a very young Scientific Association.

The following statement relative to the magnetic survey of South Africa has been kindly furnished to me by Dr. Beattie: "The observational work in connection with the preliminary magnetic survey is now almost completely reduced. The delay in publishing the results is due to the fact that all the reductions have been made twice to ensure as few errors as possible. The report will be sent to press by the end of July of this year. Observations have been made of 433 stations in all, extending from Agulhas to the Victoria Falls. At over 20 stations widely distributed observations have been made at different times to determine the secular variation of the magnetic elements. The instruments used have been compared with those of the Discovery, the Gauss, and of Major Chaves, Director of the Meteorological Service in the Azores. By means of the latter comparison the survey instruments have been compared with those in France. A number of important conclusions have been drawn with respect to the magnetic state of South Africa, which are of economic value. The survey has also been the means of filling a gap in our knowledge of the magnetic state of the earth."

It is to be feared that notwithstanding what science has done in the way of promoting the comfort of mankind, of relieving human suffering, and of adding to the material welfare of the community, it does not hold the high place in the estimation of the general public throughout our Empire which is assigned to it elsewhere. This is strikingly exemplified by a plebiscite taken recently by a Paris newspaper, which invited its readers to reply to the question as to who, in their opinion, were the ten greatest Frenchmen of the nineteenth century; with the result that, out of a total return of fifteen million votes, Pasteur was afforded first place, with 1,300,000, his majority over Victor Hugo, who was placed second, being no less than 100,000. Included in the list also were the late Dr. Curie and Dr. Roux, of the Pasteur Institute. The *British Medical Journal*, from which these figures are taken, points out how different would have been the result of such an appeal to the people of Great Britain; and in support of its assertion mentioned the fact that when the Order of Merit was instituted, although there was naturally a good deal of difference of opinion as to the names proposed, there was one name as to which disagreement could scarcely have been expected; yet in more than one of the alternative lists suggested, the name of Lister was conspicuous by its absence.

Fortunately, however, men of science are not as a rule influenced, at least, in so far as the prosecution of their investigations is concerned, by material considerations, or the position assigned to them by the public; but are content to search after truth for its own sake, realising that what has been done is infinitesimal compared with what yet remains to be accomplished, and that, in the words of Principal John Caird: "The history of human knowledge is a history on the whole of a continuous and ever accelerating progress. In some of its departments this characteristic may be more marked and capable of easier illustration than in others. External accidents, affecting the history of nations, may often have disturbed or arrested the onward movement, or even for a time seem to have altogether obliterated the accumulated results of the thought of the past. But on the whole the law is a constant one which constitutes each succeeding age the inheritor of the intellectual wealth of all preceding ages, and makes it its high vocation to hand on the heritage it has received—enriched by its own contributions—to that which comes after. In almost every department of knowledge, the modern student begins where innumerable minds have been long at work, and with the results of the observations, the experience, the thought and speculation of the past to help him. If the field of knowledge were limited, this indeed, from one point of view, would be a discouraging thought; for we should in that case be only as gleaners coming in at the close of the day to gather up the few scanty ears that had been left, where other labourers had reaped the substantial fruits of the soil. But, so far from that, vast and varied as that body of knowledge, which is the result of past research, may seem to be, the human race may, without exaggeration, be said to have only entered on its labours.

to have gathered in only the first-fruits of a field which stretches away interminably before it."

Under such circumstances, it need hardly be pointed out that a Society such as ours will not, in our time nor in that of our children's children, lack abundant opportunity for useful work; and further, the prosecution of the many branches of science will enable us more and more to realise with Schiller: "O wunderschön ist Gottes Erde and schön auf Ihr ein Mensch zu sein."

SECTION A.

Mathematics, Physics, Astronomy, Meteorology, Geodesy and Geography

Section A.

PRESIDENTIAL ADDRESS.

By E. Nevill, F.R.S., F.I.C., F.R.A.S.

The subject I have chosen for my address to this section is the theory of the motion of the moon—a subject which I have selected as one which not only calls for review at the present time, but as one which in future will always be associated with South Africa. It is true that the theory of the moon is usually associated with complex mathematical developments and as depending on many abstruse astronomical considerations; yet the mastery of these is not essential to the proper understanding of the recent advances that have been made in our knowledge of the subject.

The moon may be regarded as moving round the earth in an elliptical orbit which is constantly changing in dimensions and position owing to the disturbing action of the sun; but in practice, for convenience of calculation, astronomers regard the moon as moving uniformly in a circle round the earth, with this motion affected by a great number of separate small inequalities, each altering the position of the moon as if its centre was revolving in a small circle; the radius of the circle representing the "*co-efficient*," the time of revolution representing the "*period*," and the time when it begins to increase representing the "*epoch*" of the inequality. Some of the "*inequalities*" make a revolution in a few days and are said to be *terms of short period*, but others take years for a complete revolution and are said to be *terms of long period*.

A considerable number of astronomers have calculated in this way tables giving the motion of the moon according to the theory of gravitation, but until some fifty years ago, none of the tables which had been calculated were sufficiently accurate to enable the moon's place to be predicted with such truth that the moon could be used as a correct clock, and that is the main purpose to which both sailors and astronomers wish to put the moon. It is easy for them to determine the position of the moon in the heavens with some exactness; and if the tables of the moon were sufficiently accurate, they could learn from the Nautical Almanac the exact Greenwich time when the moon occupied that position; then the difference between that time and the local time of their observation of the moon would be their longitude on the earth. Now in round numbers the moon moves one second of arc in two seconds of time, and over the greater part of the earth, one second of time in longitude corresponds to a distance of about one-third of a mile. Hence to find your position on the earth to a mile, you must know the time from the moon to within three seconds, and so be able to predict the place of the moon to within one-and-a-half seconds of arc.

The earlier tables of the moon could not be trusted to give the true position of the moon to within 15″ to 20″; so that in taking the moon as your clock you might be in error by thirty to forty seconds of time, and so could not be sure of your position on the earth by ten or more miles.

But some sixty years ago new tables of the moon were calculated by Professor Hansen at the cost of the English Government, and they were published in 1857. These tables were found to be far superior to any previous ones, for the places of the moon calculated from them were found to agree within three or four seconds of arc with the true places, thus reducing the error of the moon when used as a clock to some six or seven seconds of time, and the corresponding uncertainty of the longitude of a position on the earth to less than a couple of miles. This was much better than the previous uncertainty of ten or twelve miles; hence these lunar tables of Hansen's were generally adopted and have remained in use to the present time.

For ten years everything went on well, and the errors of the tables remained small, but then they began to grow steadily larger, till by 1875 the moon, regarded as a clock, was from ten to thirty seconds fast, by 1885 the error had grown to twenty to forty seconds, and by the end of the century was forty to seventy seconds too fast. This was very serious, and it was obvious that there was some error or errors in the mathematical basis of Hansen's tables. But what were these sources of error?

The simplest plan for ascertaining this appeared to be to compare Hansen's theoretical results with those which had been obtained by Delaunay, and published some years after Hansen's tables. The two results agreed. There were differences, but they were too small to account for the large errors in Hansen's tabular place of the moon revealed by the observations. Hence this comparison showed that whatever might be the origin of these errors, it was not due to mistakes in Hansen's calculation of the effects of the disturbing action of the sun upon the moon. Critical examination of the basis of Hansen's tables failed to reveal any possible explanation of the origin of these discordances, except in the value that had been deduced by Hansen for the effect of the disturbing action of the planets.

Hansen's tables contained two large inequalities of very long period. One arising from the direct action of the planet Venus on the moon with a co-efficient of over fifteen seconds of arc and a period of 273 years, and the other due to the indirect disturbing action of Venus with a co-efficient of over twenty-one seconds of arc and a period of nearly 240 years. Hansen had found great difficulty in calculating their values, and finally had adopted for the second of these terms the value of the co-efficient and epoch necessary to make his table agree with the observations between 1750 and 1850. Now, already in 1862, Delaunay had questioned the accuracy of the values assigned by Hansen to this second term, and

stated that according to his calculation the value of its co-efficient should be only a $\frac{1}{4}''$ instead of $21\frac{1}{2}''$, and its greatest value should be reached in 1859, and not in 1828 as supposed by Hansen. Hansen denied that Delaunay's calculations were complete, and as long as Hansen's tables were found to agree with observation, astronomers were content to accept his conclusions. But when serious discordances arose between the tabular and observed places of the moon, and Professor Newcomb shewed that the tables were as erroneous for observations before 1750, as they were previous for observations since 1870, it became certain that Hansen's value for this indirect Venus term must be erroneous. Here, then, seemed to be the error which was destroying the accuracy of the tables of the moon.

But when Delaunay's values were substituted for Hansen's, the amended tables proved worse than Hansen's, and would not agree with the observations for any period whatever. Yet Delaunay's calculations were certainly accurate, for they were verified by several astronomers and found free from error.

There had arisen a complete dilemma.

For years no solution could be obtained. Then in 1886 an investigation made in South Africa afforded a possible solution, by shewing that though Delaunay's results were accurate as far as they went, yet they were not complete, as he had not fully taken into account the effect of the disturbing force of the sun on the minute perturbation due to the disturbing action of the planet. But the labour of calculating this omitted portion of Delaunay's investigation was so enormous that no one would undertake the work, and as it involved only a great mass of small terms, the astronomers who had verified Delaunay's calculation were of opinion that the enormous work, even when performed, would only yield small corrections to the values found by Delaunay. Hence they tried to explain the failure of Delaunay's values to represent the observations as due to the existence of yet other undiscovered large terms of long period arising from the perturbation of the planets.

Yet this explanation failed; repeated investigation failed to discover any other large term of long period, and it was shown that if Delaunay's method of calculating these terms sufficed to yield nearly the full value of these terms, then there could not be any other large terms of very long period. Here was the dilemma worse than ever!

As the Lunar Theory could not be left in such a state, the work necessary to solve this dilemma was undertaken at the Natal Observatory.

First: Hansen's theoretical values for the perturbations of the moon due to the direct disturbing action of the sun were verified, and it was shewn that when more accurate values were employed for the moon's eccentricity and inclination and the solar parallax, the results were in complete accord with those yielded by the observations.

Second: An improved method was devised for calculating the perturbations due to the planet, and approximate values obtained

for the values of the principal term, shewing that the values employed by Hansen required correction, and that he had omitted a large number of these terms, which must be included before the lunar tables could be brought into accord with observation.

Third: The whole available series of observations of the moon since 1620 were reduced to a uniform basis and compared with Hansen's lunar tables, and their errors deduced for different epochs.

Fourth: The long series of discordances between Hansen's tables and observation were utilised for determining the corrections to the elements adopted in Hansen's tables, and for deducing the apparent value of the co-efficient, epoch, and period of every inequality of long period shewn by the observations to exist in the complete expression for the motion of the moon.

Fifth: It was shown that when these corrections and additions were made to Hansen's tables they sufficed to represent completely the whole of the observed positions of the moon since 1650.

The whole of this work was completed and ready for publication before the end of 1894. But the publication had to be deferred because no funds could be obtained. Had it not been for this, South Africa would have reaped the entire credit for the recent improvements in our knowledge of the motion of the moon and have furnished astronomy with the new lunar tables that are so much wanted. Unfortunately, funds could not be obtained; the publication had to be deferred; other astronomers, tired of waiting for these results, were led to take up different portions of the work, and the credit for priority in the recent advances in our knowledge of this important branch of astronomy has passed away from South Africa.

In 1898 the work of verifying and extending Hansen's theory was taken up by Professor Brown in America, and brought to a conclusion in 1905. The results obtained are in complete accord with those obtained in Natal, though they are more extensive and elaborate.

In 1894 the extension of Hansen's calculation of the perturbations due to the planets, was taken up by M. Radau in France, and many of the new terms which had been calculated in Natal were independently discovered and calculated. The results, so far as they go, are in accord with those obtained in South Africa, but the calculation has not been pushed far enough to obtain the complete values, so M. Radau's results are not in full accord with the results yielded by the observations.

In 1903 Mr. Cowell, of the Royal Observatory, undertook the work of comparing the Greenwich observations of the moon made between 1750 and 1902 with Hansen's tables, and employed the observed discordances for determining the apparent errors of Hansen's tabular co-efficients, as well as the apparent co-efficients indicated by the observations for certain terms arising from the disturbing action of the planets which had been calculated from theory by M. Radau. The results obtained by Mr. Cowell are in general harmony with those already obtained in Natal. It was found that

the observations indicated values for these co-efficients in close agreement with those derived from theory by Hansen for the effects of the disturbing action of the sun. He confirmed the conclusion that the tabular place of the moon could not be brought into accord with observation except by the introduction of a new term of very long period, together with a number of smaller terms of shorter period arising from the disturbing action of the planets. He shewed that the observed values of the perturbation due to the planets differed considerably from those assigned by M. Radau as yielded by M. Delaunay's method of calculation, and that the observations yielded much smaller values for the perturbation due to the figure of the earth, than those obtained by Professor Hill, also by means of Delaunay's method. Hence Mr. Cowell's investigation, like the earlier South African ones, yielded strong indications of the incompleteness of the values derived from theory by the use of Delaunay's method of calculation as hitherto employed.

Hence the present state of the lunar theory appears to be that it is impossible to represent the observed position of the moon unless there be introduced into the tables one or more new large terms of long period which cannot be deduced from the known disturbing forces by the use of the final equations in the form obtained by Hill and Radau from Delaunay's method of developing the theory of the moon. Hence if these equations be considered as yielding the complete value of the terms of very long period, then, as urged by Professor Newcomb, "the cause of the observed changes of long period in the moon's mean motion remains the greatest enigma in gravitational astronomy."

Yet the explanation of this enigma has been yielded by South Africa, and it is to be found in the proof that has been given of the incompleteness of the results yielded by the final differential equations which have been employed of late. When the complete values are obtained of the terms of long period due to the indirect action of the planets, they are found to be much larger than those yielded by Delaunay's equations as hitherto employed, and furnish values in harmony with those yielded by the observations and published as one of the last communications on the lunar theory dated from South Africa.

2—NUMERICAL SUMMATION OF THE RECIPROCALS OF THE NATURAL NUMBERS.

By R. T. A. Innes, F.R.A.S.

[Abstract.]

To obtain the sums of the fractions $\frac{1}{1}$ to $\frac{1}{9}$, $\frac{1}{10}$ to $\frac{1}{99}$, and so on, the summation formula

$$\Sigma \frac{1}{p} = C + \log_e p + \frac{1}{2p} - \frac{1}{12p^2} + \frac{1}{120p^4} - \frac{1}{252p^6} + \&c... \text{(a)}$$

could be used. It will, however, be better to use a modification of a formula given by Schlömilch (Compendium II., 1895, p. 234). It is as follows:—

$$\Sigma\frac{1}{10^{n+1}-1} - \Sigma\frac{1}{10^n-1} = \log_e 10 + \tfrac{1}{2}\frac{10-1}{10^{n+1}} + \frac{B_1}{2}\frac{10^2-1}{10^{2n+1)}} - \frac{B_2}{4}\frac{10^4-1}{10^{4(n+1)}} + \ldots$$

wherein B_1, B_2, etc., are Bernouilli's Numbers.

For numerical application this formula may be written ($n=0$ being excluded):—

$$\begin{aligned}\Sigma \frac{1}{10^{n+1}-1} - \Sigma\frac{1}{10^n-1} = \log_e 10 &+ \frac{1}{10^n} \times 0.45 \\ &+ \frac{1}{10^{2n}} \times 0.0825 \\ &- \frac{1}{10^{4n}} \times 0.0083325 \\ &+ \frac{1}{10^{6n}} \times 0.00396825... \\ &- \frac{1}{10^{8n}} \times 0.00413223I... \\ &+ \&c.\end{aligned}$$

Thus, it is seen that as n increases, the sums of the parts tend towards the limit $\log_e 10 = 2.302585093$.

The sums of the earlier parts of this infinite series are:—

1	to	$\frac{1}{9}$	=	2.8289683
$\frac{1}{10}$	"	$\frac{1}{99}$	=	2.3484093
$\frac{1}{100}$		$\frac{1}{999}$	=	2.3070933
$\frac{1}{1000}$	"	$\frac{1}{9999}$	=	2.3030352
$\frac{1}{10000}$	"	$\frac{1}{99999}$	=	2.3026301
$\frac{1}{100000}$	"	$\frac{1}{999999}$	=	2.3025896

Adding these parts together and increasing the total by one-millionth, we have for the sum of the reciprocals of the natural numbers up to one million, or

$$1 + \tfrac{1}{2} + \tfrac{1}{3} \ldots\ldots \text{ to } \tfrac{1}{1000000} = 14.3927268$$

The direct use of formula (a) yields 14.3927267, an agreement within the chosen limit of accuracy.

3—SOME RESULTS OF A MAGNETIC SURVEY OF NATAL.

By J. C. Beattie, D.Sc.

The observations on which the results of this paper are based were taken in 1903. The thanks of the writer are due to the Government of Natal for their help in this work; and they are in particular due to Mr. Massen, Surveyor-General, for his kindness and for the trouble he put himself to in order to make the labour of observing as pleasant as possible, and to Mr. Nevill, our President, who gave much valuable assistance and information.

The instruments used were Dip circle 142 by Dover, and Magnetometer 73 by Elliot; a theodolite and a chronometer. It was possible to rate the chronometer several times weekly by interchanging signals with the Government Observatory in Durban.

The latitude and the longitude of each station was determined, and the magnetic elements observed were the declination, the dip, and the horizontal intensity.

From these latter the vertical, the total, the westerly, and the northerly intensity were calculated. All magnetic results have been reduced to the epoch 1st July, 1903.

To reach the conclusions which can be drawn from the whole survey, the results were grouped thirty at a time. In this way a mean value of the particular element concerned was obtained at an imaginary station whose latitude and longitude was the mean of the latitude and of the longitude of all the stations.

There are two such mean stations for Natal, I., II., whose latitudes and longitudes and the values of the magnetic elements there, are given below :—

Station	Lat.	Long	D.	H.	θ	Z	T	X	Y.
I.	29°43′ S.	30°31′ E.	23°45′ W.	·18127	61° 6′ S.	·32838	·37510	·16625	·07311
II.	27°39′ S.	30° 3′ E.	22°23′ W.	·18753	59°37′ S.	·32008	·37100	·17327	·07207

Where D is the declination reckoned positive towards the W.

H is the horizontal intensity.

Θ is the dip reckoned positive when the South Pole is below the horizon.

Z is the vertical intensity reckoned positive towards the zenith.

T is the total intensity.

X is the northerly intensity.

Y is the westerly intensity.

The next step was to form an equation—for each station used in the group—of the form

$$x\,(\Phi_m - \Phi) + y\,(\lambda_m - \lambda) = \Theta_m - \Theta$$

Where Φ_m λ_m are the latitude and longtitude of the imaginary station

Φ λ ,, ,, an actual station

Θ_m Θ the dips at the imaginary and the actual station respectively.

Similar equations were used for the other magnetic elements.

x and y were determined by Caneby's method, and give the variation with latitude and longitude of the different elements.

As soon as the mean variation with latitude and with longitude has been found in this way, it is possible to determine at the actual stations what the values of the elements would be had the variation been uniform and not variable as it actually is. The difference between the actual and the values calculated according to this method may be called the magnetic anomaly. It is from these anomalies that the conclusions have been derived.

The nomenclature adopted is that of Thorpe and Rücker modified for convenience.

A Ridge line is a line of country which attracts the South Pole of a magnet, a valley line one which repels it. A peak is a point towards which the anomalous horizontal forces converge.

Natal-Zululand Ridge Line.—A ridge line extends from the east coast, starting between Umhlatuzi and Ginginhlovu railway stations, passing north-west to a point whose approximate lat. and long. is 31° 30 E and 28° 55′ S respectively, then turning south-west, and continuing in that direction to a point a little south of Boston; there its course changes and passes northwards between Boston and Bulwer, to the west of Fountain Hall, Estcourt and Modderspruit. It then goes east, turning north again near Waschbank, and passing to the west of Dannhauser. On this line there is a peak between Umhlatuzi and Ginginhlovu, in a district of maximum vertical force. The next peak is between Boston and Bulwer, approximate lat. 29° 40′ S., approximate long. 29° 20′ W. There another ridge line goes off from the one already referred to and passes to the north of Bulwer and of Underberg.

The directions of the horizontal disturbing forces at Bulwer, Underberg, Boston and Fountain Hall, point towards this peak. A valley line starts between Modderspruit and Waschbank, and passes south to intersect the first ridge line about Dalton, thence continuing probably to the east of Kranzkloof.

Griqualand East and South Natal Valley Line.—Another valley line passes between Rietkuil and Kokstad N.E. by E., south of Richmond, Krantzkloof and the Bluff, and north of Ibisi Bridge, Umzinto and Illwo River; it then continues in a more northerly direction to the east of Mount Morland, Stanger and Ginginhlovu.

Griqualand East and South Natal Ridge Line.—Another well-marked ridge line passes from a little south of Mount Frere in a north-easterly direction, keeping south of Kokstad, Ibisi Bridge and Umzinto; there it turns to the north, and is continued east of Illwo River and probably through Durban.

The Natal-Zululand ridge line runs practically perpendicular to the magnetic meridian from Ginginhlovu to Boston; its origin is probably due to magnetic matter at no great depth and not very widespread at that depth.

It has already been stated that a ridge line is one which attracts a south-seeking pole. Hence when such a region extends roughly east and west, the horizontal intensity to the south of it will be less than the average, and to the north greater. In the case

of this particular ridge line, Umhlatuzi, Greytown, Albert Falls, Dargle Road and Boston, all to the north of it, have horizontal intensities greater than the average, whereas Grange, Camperdown, Dalton, Stanger and Tugela, on the south, have values less than the normal.

The dips to the north and the south of such a line of attraction will be less and greater respectively than the normal values. The dips at the above stations are such as to be in agreement with the suggested position of the ridge line, except in the case of Boston. The explanation of the difference in this case is probably due to the cross ridge line—which passes north of Underberg—continuing east to the north of Boston.

The second part of the Natal-Zululand ridge line is not so certainly marked; its position throughout a considerable part of its length depends on observations at a single line of stations only. Here the ridge of magnetised matter runs north and south, and—the declination being west—stations to the east of such a line ought to have a declination less than the average, stations to the west a greater declination. Boston, Fountain Hall, Estcourt, Colenso and Dannhauser have declinations smaller than is to be expected, and therefore lie to the east of the line, Modderspruit and Waschbank greater values, thus fixing their position to the west. The directions of the disturbing horizontal forces support this, with the exception of that at Modderspruit; there, instead of being directed towards the ridge line, as drawn from the declination results, it is directed away from it. At that point there is, therefore, an ambiguity in the position of the ridge line.

The valley line which starts between Modderspruit and Waschbank begins at a col—that is, a point on a ridge line where the vertical force has a minimum value; the existence of such a line is supported by the value of the declination at Greytown, which is greater than the normal, and which. therefore, is to the east of a valley line. This valley line probably continues through Dalton, east of Krantzkloof and west of Durban.

The Griqualand East and Natal valley line separates a region of higher horizontal intensity on the south from one of lower in the north. The dip results are also strongly in support of this line being considerably lower to the south and higher to the north. In the case of all the stations in the neighbourhood of this line the direction of the horizontal disturbing forces is—as it is to be expected—away from it, with the one exception of Richmond.

4—NOTE ON A GAS-VOLTAMETER FOR EXACT USE.

By R. A. Lehfeldt, D.Sc., B.A.

5—THE INTENSITY-DISTRIBUTION OF RAINFALL OVER THE WITWATERSRAND.

By H. E. Wood, M.Sc.

[Abstract.]

The rainfall records for the period of ten years 1897—1906 at a large number of stations within the Central Witwatersrand district of the Transvaal have been treated statistically, and compared with a ten years' series of rainfalls recorded at the Greenwich Observatory, England. Tables have been deduced giving the mean probabilities of daily rainfalls of varying intensities in the two regions. The comparison shows that over the Transvaal excessive rainfalls are to be expected with varying degrees of probability in each of six months of the year, while in England similar rainfalls are only likely to occur in three months out of the twelve, and with a much smaller degree of probability. A further comparison-table shows that only 20% of the Transvaal rainfall falls in what may be classified as light, directly beneficial showers, against roughly 50% of the English rainfall; whilst about 60% of the Transvaal rain falls in heavy showers against only 25% of the English rainfall. It is therefore inferred that the greater part of the Transvaal rainfall is not directly beneficial to the soil, and, unless conserved, is lost to the Colony.

Finally a suggestion is made as to a system of measuring the rainfall distribution of any region on a certain scale, following a mechanical analogy. This system applies the figure *59* to the Transvaal rainfall and *36* to the English rainfall, the numbers being intended to be roughly inversely proportional to the beneficial value of the rainfall distribution.

6—SOLAR ACTIVITY IN 1904-1907.

By H. D. Badcock, M.A., M.Inst.C.E., F.R.A.S.

[Abstract.]

Deals with 466 observations of the sun made at Pretoria between December, 1904, and April, 1907, and of 397 spot groups with transit theodolite and 3⅝″ O.G.

Describes determination of period of rotation, inclination of solar axis, and motion and latitude of spots.

History of solar activity for period.

Notes on phenomena characteristic thereof.

7—THE BAROMETRIC DEPRESSION AND COLD WAVE OF JULY.

By J. R. Sutton, M.A., D.Sc.

8—NOTES ON RAINFALL IN FOREST REGIONS.

By W. Reid-Bell, F.R.Met.Soc.

Professor Schubert, of Vienna, points out that the Silesian rain-chart is to a certain extent a reflection of the relief map of the country, the annual precipitation varying from 600 to 700 mm. in the lowlands to 800 mm. as the edge of the Silesian Highlands is approached, the isohyetals showing tongues projecting into the lowland districts over certain wooded areas. Precipitations of over 800 mm. are only found in the mountains, but probably the zone of maximum precipitation lies below the highest summits which in winter often project above the clouds. Professor Schubert combines the districts of the Province into 26 groups, each with approximately equal percentage of forest land, and arranging the groups in 5 divisions, arrives at the following average values :—

Percentage of Woodland.	Elevation above Sea Level, metres.	Rainfall in mm.
11	222	650
21	181	655
28	271	715
35	516	848
48	157	646

and he finds the rainfall in millimetres to be $529+0.78p+0.57h$. where " p " is the percentage of afforestation and " h " the elevation above sea level in metres, so that there is an increment of 0.57 mm. for each metre of elevation and of 0.78 mm. for each one per cent. additional of forest land in the area.

In the course of discussion he gives the curve of increase of the rainfall due to afforestation as a curve steep at first and flattening off till it becomes nearly level at 50 % afforestation, so if the Silesian forests, occupying 29% of the country, were increased till they occupied 50% or even more, the rainfall, Professor Schubert concludes, would only be increased by 6 mm. or one per cent.

A rain chart of the forest region of Oppeln is given, in which the gaugings from Sept. 1900 to June 1904 are reduced by the aid of the foregoing ascertained rate of increase of .57 m.m. per metre elevation, to a uniform elevation of 180 metres above sea level, the results showing an increased annual precipitation within the forest of 50 m.m., as compared with the rainfall in the open country, but one half of this is attributed to the influence of the protection from wind afforded to the gauges within the forest.

Comparing this with the increase due to elevation, it is concluded that the afforestation corresponds to an additional elevation of the land surface of 40 metres, and that probably the woodland exercises no other influence upon the rainfall.

The author discusses the manner in which the air currents passing over forest areas are diverted upwards and checked, and the consequent effects upon the temperature and pressure resulting in increased precipitation, and concludes that the effect of increase is

produced more by the retardation of the air currents passing through the trees, than by any direct upward deflection due to the vertical surface exposed to the wind.

It is pointed out that the Transvaal is under conditions different from those in Silesia, and the effects of afforestation upon the rainfall there may not be the same as in Silesia, although there is no reason to think that woodland exercises any direct influence other than in the way of modifying temperature and pressure.

It is urged that the conditions of exposure to the rain winds, the hygrometric conditions during rainfall, the temperatures and pressures during rain winds, etc., are details which must all be recorded in connexion with the subject, before a complete study of the problem can be undertaken, and it is suggested that woodland further may have an effect upon the actual amount of moisture present in the atmosphere.

In this connexion, part of the rainfall of a country may be due to local circulation of water between the earth and atmosphere, as well as to the general circulation between the land and water surfaces of the globe.

9.—ANTI-CYCLONES AS AIDS TO LONG DISTANCE WEATHER FORECASTS IN SOUTH AFRICA.

By Col. H. E. Rawson, C.B., R.E., F.R.Met.Soc.

This paper is a continuation of one upon the influence of anti-cyclones in determining South African weather, read before the Association at Kimberley last year. The author analyses the isobaric charts of the southern hemisphere which have been published from time to time since 1868, and points out that they differ greatly in the disposition of the anti-cyclonic systems. The reason for this is attributed to displacements of the high pressure belt in which the systems move, as well as to progressive movements of the systems themselves, which are not the same in successive years. Examining all available South African records, he has been able to detect the years wherein the weather indicated that the belt had reached the extreme limits of its range, and he puts forward some strong reasons in support of a cyclic movement with a period approaching 9 years. A reason for the recent years of drought is given, and the future weather prospects of Natal are discussed.

10—DISCUSSION ON A STANDARDISING LABORATORY FOR SOUTH AFRICA.

A discussion on the utility of a central standardising laboratory for South Africa was opened by Prof. R. A. Lehfeldt, D.Sc., and continued by Messrs. E. Nevill, R. T. A. Innes, J. Roberts, E. H. V. Melvill, J. Moir, and others.

A resolution in favour of establishing such an institution was passed by the section and submitted to the Council.

At the subsequent meeting of the Council, a Committee was appointed to endeavour to draw up a practical scheme for a standardising laboratory, and to approach the Colonial Governments on the subject. The Committee consists of :—Dr. Beattie (Cape Town); Mr. Ehrlich (Bloemfontein); Mr. Melvill (Johannesburg); Dr. Moir (Johannesburg); Mr. Roberts (Durban); Prof. Lehfeldt (Johannesburg) (convener).

SECTIONS B AND C.

Chemistry, Metallurgy, Mineralogy and Geology; Engineering, Mining, Architecture.

Sections B and C.

PRESIDENTIAL ADDRESS.

By C. W. Methven, M.I.C.E., F.R.S.E., F.R.I.B.A.

The subject with which I have been most closely identified in South Africa is, as I daresay many of you know, that of its Harbours, but I have so recently contributed a paper on these to the Institution of Civil Engineers in London (a good deal of which has been published in the Press) that I do not propose to make it the principal theme of this address, which otherwise I might have done. I propose rather to venture upon a few remarks of a general nature touching one or two of the various headings comprised under this section, but in particular those of Engineering and Architecture.

We are now well into the beginning of a century which promises, in the domain of scientific research and discovery, to eclipse even the 19th Century, the most wonderful the world has ever seen, and I think many of the younger members of this Association will live to see this prediction verified.

At the present moment thousands of eager and highly organized intellects are hard at work all over Europe and America, and may we not add South Africa, on problems in Chemistry, Biology, Physics, Astronomy, Geology, Electricity, Aerostatics, etc., some of which appear to be on the brink of solution, and which will then revolutionise not only the methods of to-day, but open up still newer fields for invention and discovery, and flood with light the dim vistas of those realms of speculation in which many of us are groping for truth, in directions not only leading towards the amelioration of our temporal wants and necessities, but towards the elimination of the false and the determination of the true as affecting the religions of humanity.

The address then dealt shortly with some of the problems enumerated above, and proceeded as follows:—

But no period in the world's history has been so prolific of discovery and invention as the century we have so recently left behind us. The heritage which has been bequeathed to the youth of to-day by their immediate forefathers, is one which will make calls upon their intellectual powers as well as on their manhood, which will tax their energy and resourcefulness to the utmost degree if they are to keep pace with the times in which they live, let alone take a lead in the work of advancement along the lines of scientific thought and discovery. The recognition of this by the older minds is leading, I am glad to say, in this country to the establishment of technical schools which will be of inestimable value to its young men and

women, and I am pleased to be able to state that the movement has taken root in this Colony as well as the Cape and Transvaal, and that technical schools will shortly be established both in Pietermaritzburg and in Durban, leading I hope eventually to a University.

We are passing just now through troublous times, and retrenchment is in all directions the order of the day, but I hope that Colonists will insist on the various Governments giving the fullest and most generous encouragement to the establishment of technical schools, as one of their first duties to the country and the Empire, and as one which, if efficiently carried out, will do more than anything else to promote its ultimate prosperity.

It is a necessity that all classes out here should see that their sons and daughters, are afforded the opportunity of keeping pace with the intellectual advancement of the age they live in, otherwise they will have to stand down and make place for the better educated young man or woman from the old country.

After reviewing the progress of Engineering during the last Century, special reference was made to Marine Engineering as follows:—

The harbours and docks of the United Kingdom 100 years ago were comparatively few in number and of limited capacity, while their appliances were of a primitive nature. The enormous increase in the size of steamships has changed all that also, and the invention of high pressure hydraulic machinery and the electric motor has revolutionized appliances for the economical handling of goods. A number of these appliances can now be seen at some of our own harbours in this country, and I think, there is on the whole no better equipped harbour in South Africa than that of Durban, and few more up-to-date in many respects even in the old country, although I am not so sure of this as regards its coaling appliances. As regards its system of platform sheds and hydraulic cranes, I came across no more perfect arrangements at any harbour I visited in a somewhat extended and recent tour in England and on the Continent, although when I introduced the system in 1890 I was told by some of our local lights that it would never work.

There are, perhaps, few appliances in which greater developments have taken place in a short period than the modern sand-pump dredger. I am safe in saying that this invention has rendered possible the opening up of river mouths and the formation of harbours at sites where not more than 30 years ago this would have been out of the question.

The address then touched upon the history of this invention and its development up to the powerful machines now in use at Durban Harbour, of which the author was engineer-in-chief. Proceeding he said:—

I afterwards prepared a specification for the "Octopus," the first of the class in this country. Her hopper capacity was 1,200 tons. Experience since then has led to a considerable increase in the hopper capacity of these vessels.

The main suction pipe of the "Octopus" was 44 inches internal diameter, with flexible joint to withstand the movement of the vessel, placed in a central wall in the bow, and of sufficient length to dredge considerably below the depth required for navigation. There were two sets of independent triple-expansion engines in addition to the propelling engines, driving two 33in. centrifugal sand-pumps working out of the main suction pipe, and these could be worked separately or together as required. The suction-pipe and hopper doors for discharging the dredged material were controlled by hydraulic power. The propelling machinery consisted of two sets of triple-expansion engines driving twin screws to give a speed of 9½ knots per hour. On one occasion, a piece of bar iron weighing 87 lbs. was sucked up by the pumps of a sister vessel, the "Walrus," and pieces weighing upwards of 56 lbs. have frequently been brought up by both dredgers. The plan of dredging well below the required navigable depth outside the entrance, and thus making allowance for any shoaling during rough weather, I saw in use in Holland, in 1888, where it was regularly practised by the Dutch, who at that time were considerably ahead of English engineers in sand-pump dredging.

The contract dredging capacity of the "Octopus" was 3,000 tons of sand per hour, but her record time in filling her hopper with 1,200 tons of sand was about 13 minutes or nearly 100 tons of sand per minute.

This boat inaugurated, as I pointed out to the Legislature in 1895, the commencement of "greater experiments of outer sea dredging than had probably been tried in any other part of the world."

The conditions existing at the entrance to Durban Harbour at this time, however, were not favourable to successful dredging operations. The southern work at Durban on the weather side of the entrance, known as the South Pier, from which the sand travel came, overlapped or protruded further into the sea than the northern work by some 700 feet, and a spit or tongue of sand constantly formed under the lea of the projecting work, while the outflowing tide followed the line of least resistance round the head of the shorter North Pier, tending to form a northern channel there.

I insisted on the absolute necessity for the immediate extension of that work. The dredger could only work on the line of the axis of the Bluff or Entrance Channel, that is straight out to sea. To have worked further to the Northward, with the tides, would have brought her broadside on to the seas, and would have been dangerous if not impracticable. In fact, to put it shortly, the dredger could only work in one direction, while the tides worked in another. Nature was being pitted against the artificial power of dredging, and even if she did not win, yet the result would be to greatly increase the annual cost of dredging instead of reducing it to a minimum by bringing forward the North Pier abreast of the breakwater, and inducing the two powers to work together.

This view was greatly opposed by some of those in authority, who considered that an extension of the North Pier would merely drive the bar further out to sea beyond the reach of the dredgers. It was a point absolutely vital to the success of the Durban Harbour works, and therefore to the Colony. Its gravity was such that I felt bound to fight for my views to the utmost extent in my power, though at the time I did so unsuccessfully.

My views were subsequently submitted to and confirmed by independent engineers, and a year or two afterwards, the Government extended the northern work to its present position and destroyed the overlap, and dredging was carried on under the favourable conditions which I had so strongly advocated. That is, the scour induced and trained by the extension of the North Pier, was brought to bear in assisting and maintaining the work of the dredgers. The result has been that the average depth at low water on the bar for last year was 30 feet, or 36 feet at spring-tide high water, and the largest mail steamers now enter and leave the harbour in perfect safety.

Prior to the extension of the North Pier, there is no doubt whatever that the natural tidal scour and the dredging were largely opposed to each other, and the liability of the bar to the sudden shoalings which frequently took place during very short spells of bad weather, sometimes lasting not more than from 24 to 48 hours, reduced the depth much below the loaded draught of the dredgers, and made it impossible to work these effectively, or with any hope that their work would be maintained.

My view of dredging was expressed in a report to the Natal Harbour Board, in 1892, as follows:—"If the North Pier is not extended, the only course will be to tax the revenue of the Port for all time, in order to keep it open as far as possible by dredging, an expedient which will not only be a millstone for ever round the neck of the port, handicapping it severely in the face of competition with other ports, such as East London and Delagoa Bay, but will only be temporary and intermittent in its effects according to weather, while it will certainly fail of itself to bring about and maintain with any degree of certainty such a depth as we require to constitute this a first class port for the accommodation of the large mail steamers."

Happily the difficulty was overcome by the long delayed extension of the North Pier, with the results described.

It must not be imagined, however, that with the advent of this useful invention these bar problems have become any easier to solve so far as the necessary works are concerned. Heavy dredging, when unfortunately it is required to supplement the natural forces, involves in some cases, a large annual expenditure, which must go on for all time.

It is, therefore, the first duty of the engineer to see that in the disposition of the works, he utilises to the utmost degree, and in the most effective and economical manner, any natural forces available, so as to minimise the amount of dredging necessary: and it is here that the problem is as great as ever.

One of the most important factors affecting the design and development of the modern harbour is naturally suggested by the subject of the deepening of entrance channels and bars by dredging, and that is the extraordinary increase which, during the last century, has taken place in the size of steamships. It was thought not long ago, that the growth of steamships would of necessity be limited by the varying depths of the harbours of the world. But here again the modern sand-pump dredger has changed all that by rendering it possible to obtain much greater depths than could ever be naturally maintained, or which, indeed, in the beginning of the 19th century, ever entered into the wildest dreams of the engineer as being even remotely possible.

I will close with a reference to a point I touched upon a year or two ago in an address I delivered to the Natal Institute of Architects, when I had the honour of filling the Presidential chair, and that is as regards the building up of our towns on well-considered lines, while the opportunity is still with us, instead of, as is too often the case, in a haphazard fashion and without regard to the ultimate result from an architectural point of view. It is impossible for anyone who has lived in some of these towns during the last ten years, not to note the remarkable development which has taken place in public works in order to meet the necessities of the more rapidly growing communities. In respect of water supply, sewerage works, and sanitary works generally, the extension of macadamized roads and attendant surface drainage works, electric lighting, electric tramways, improved telephone arrangements, etc., no one can, I think, fail to admire the admirable work which has been carried out by some of the municipal bodies who have charge of the public affairs of our larger South African towns. And in this connection I think, I may fairly and without prejudice particularise the town of Durban.

The result of these admirably-executed public works, together with the great advance which in late years has taken place, not only in the rapid growth in the number of public and private buildings, but in the higher class of construction and arrangement, and the artistic treatment which is visible in many of them, has been to advance some of these towns to a position which will compare favourably with many much larger provincial towns in the old country, both in respect of cleanliness and general health conditions, and the attractiveness of their commercial centres and residential suburbs.

Criticism, however, which never gets beyond unrestricted praise, is very apt to degenerate into gross flattery, and become no criticism at all. Some of the Municipalities, especially in the younger towns fortunate enough to have been endowed by nature with exceptional natural beauties and a topography which lends itself to artistic treatment, have a great opportunity in front of them, if they can only be brought to see it. If such inestimable natural beauties are to be made the most of, than the municipalities have a wide field before them, which will demand greater effort, and an

even broader and more liberal conception as regards public improvements, than in the past.

The seaport town of Durban, for instance, has been bountifully treated by Nature. It has been given great physical advantages, which, by enlightened action on the part of the Colonists, have been directed to "the use and convenience of man," to such good purpose that we now have one of the finest ports in this sub-Continent. Nature has also been lavish in providing an ideal site for a great commercial city of unlimited dimensions, set amid surroundings of almost unrivalled semi-tropical beauty, and with extensive environments of the most charming character for residential purposes. The levels of these, while they place but few obstacles in the way of access, and development by tramway extension, raise the sites for residences to a height above sea level not only conducive to health conditions, and affording every facility for drainage purposes, but spread out before the residents such a panorama of ocean, bay, and town, as is seldom to be met with. On one of our clear-cut days after rain, when the heavens are full of the unapproachable colour which Ruskin calls "blue fire," those of us who have any eye for colour, cannot help arresting their steps to drink from the cup which Nature holds out to them, and whose contents reflect the prodigality of all that is most glorious in her many-hued vestments. Therein one beholds the shimmering sea, the placid wind-streaked Bay, and the gold and green and russet setting of wide stretching vlei and virgin bush. And embowered amid all this is a spreading city, along whose sea-girt margin flutter the "white wings of commerce," and at whose quays are moored the leviathan steamships of the greatest empire of the world. And this is only one of the many future cities of this great country, whose destiny is committed by its citizens to the Municipalities. Their artistic planning and architectural beauty depends entirely upon the spirit in which the task is approached, and the broad-mindedness and enlightenment which is brought to bear in dealing with them. And how is this to be attained? I think our American cousins have, with their usual resourcefulness, shown us the path.

Perhaps it is easier, however, to answer the question in a negative way, by pointing out how it cannot be done, and that is by laying out and building new streets, from year to year, on no definite plan, with no definite aim as regards ultimate appearance, without any definite views as to the best reservations for, and development of, public Parks, without sufficient control as regards the architectural design and construction of the buildings which are erected, by the erection wholesale of every conceivable variety of jerry-built cottage, villa, and unsightly store, the only consideration regarding which is whether it will pay the speculative builder, or the owner, who labours under the delusion that there is no commercial value in artistical design, and that a generously-minded builder is going to give him, at an absurdly lower figure, the same building as he would get through a competent architect; and by a policy,

with regard to the general laying out of the whole town, based mainly upon effecting the utmost possible economy in the sub-division of the land, so that every square yard of it shall be made directly revenue producing, and shall fetch the highest price in the market.

I do not mean for a moment to say that the above description of the way not to build up a fine city, is the path followed by the Municipal authorities of this community, or that of Durban, but I am quite sure you will agree with me that a good deal goes on in the various directions I have indicated.

On account of business considerations, this is, I think, unavoidable, to a certain extent, in a young Colonial town, but on the other hand, does not the sound old proverb, "train up a child in the way he should go, etc.," apply in these cases to a large extent?

Municipalities have of late years exercised a much keener criticism and control over new buildings, and intelligent work bestowed in this direction is becoming productive of good results in many of our towns. But this criticism and control might be productive of much better results, if building inspectors were in all cases given a higher official standing, and were invariably chosen from the ranks of gentlemen qualified for the position by thorough architectural training. It would cost a little more to provide adequate remuneration, but would be money well and profitably spent. I consider that no one has a right to erect a building within the Municipal boundaries of a town, which he intends shall contribute to his personal profit, without at the same time being required, within reasonable limits, to contribute by his building to the architectural beauty of the town.

This brings me to the point at which I am aiming, viz.—whether architects of experience and standing in the country, could not be called upon to assist the various Municipalities in the general laying out and arrangement of the towns, as a whole, as well as in their individual buildings; whether, in fact, these Municipal bodies could not, as they do in some American cities, and in some of the large cities in Europe, avail themselves more of the experience and artistic endowments of the members of the architectural profession practising in their midst, to guide them in at least many of the works of extension and improvement, which from time to time they have to deal with in the building up of what we believe will, in the future, become great and populous cities.

I would draw attention to the urgent and special need there is for such action on the part of the authorities, in connexion with the squalid buildings, and even streets, which are growing apace, owing to the license which is extended to the Indian population in some of our towns to build apparently as and what they like. The Indian may be a British subject, and have equal rights to protection and consideration with ourselves, but all the more reason therefore why he should be prohibited from poisoning and disfiguring our Colonial towns by the creation of every sort of mean and squalid Kaffir-store and trading den, which his necessities

require to enable him to oust the British shopkeeper. It is high time this aspect of the case was seen to.

It is remarkable how apathetic the public frequently is in matters vitally effecting the architectural beauties of the particular city in which they pass their lives, and in which their children's children may live after them. The building public, or that intelligent portion of it, which is able to distinguish between noble and ignoble work—between that which is refined in design, and that which is vulgar, garish, and unlearned, should, in so distinguishing, resolve to place their work where it will have capable treatment, and where the expenditure they incur, will not only result in satisfaction to themselves, but in adding another ornament to the town upon whose attractions and prosperity their own so much depends.

Given like materials, good design from both constructional and aesthetical points of view, seldom costs more than bad, and very often less. But architects themselves have a duty to perform as well as the public. They must strive by their own endeavours to educate the public taste, or how else are they to look for the encouragement they cry out for. Let them strive to make their buildings beautiful, to imbue them with the impress of their purpose, to impart to them the dignity arising from simplicity, noble proportion, and purity of style, rather than to revel in the wealth of superfluous and meaningless ornament, which one sees bespattered over so many of them. Let us make them bright, airy, cheerful, wholesome, and elevating, and without struggling for originality, throw some of our own individuality into them, where we think it good. We shall then, while looking to others to play their part, fairly meet our own responsibilities, remembering the imperishable character of the records of our time, which we are leaving behind us.

2—THE TRACING OF UNDERGROUND WATERS.

By J. McCrae, Ph.D.

There are many instances in which it is advisable to ascertain if a water connection exists underground between two points, where water is found on the surface. It frequently happens, in limestone and other geological formations, that a river sinks into the ground or passes into a subterranean passage, and for the riparian owner at some less elevated point, on whose ground water appears on the surface, it is of the greatest importance to know if there is direct connection between two such waters, in order that he may take steps to protect his water-rights. Chemical analysis of samples from the two spots may in some cases permit of the conclusion that there is no connection, but it would be rash to deduce from similarity in chemical composition that there is a connection: a geological survey of the intervening ground will usually permit of the expression of an opinion as to the probability of a direct connection between the two waters, but this will be at best an opinion. If, however, some characteristic substance be added to the water at the higher point, and if this substance appear in the water at the lower point, then a connection between the two points will have been established: a negative result would require to be treated with circumspection, but the more accurate and delicate the process employed the greater will be the value attached to a negative result.

Furthermore, the tracing of a water connection between two points is often essential in ascertaining if a water (particularly a water-supply) is being contaminated from some adjacent polluted river, ditch or pond.

Methods.—If the channel connecting the two waters is such that the water flows freely through it without impediment, floats of cork or other material may be used. The cases where floats can be used are, however, extremely few. More hopeful is the method of adding something characteristic which dissolves in the water.

The properties required of such a substance are:—

(1). It must be soluble in water;

(2) It must be unacted upon by the material through which it passes;

(3) It must be of such a nature that it will not be confused with anything naturally present in the waters;

(4) It must be easily recognised.

Sodium chloride has been used, and it fulfils the requirements in a large measure. But there are considerable objections to its use. As it is not *per se* easily recognised, it is taken as sufficient to examine if the content of chlorine of the water at the lower point increases after the addition of the sodium chloride at the higher point. A consequence of this is that a very considerable amount of sodium chloride, in proportion to the amount of water, is required to be dissolved, and this may entail the damming back of the stream in order to give the salt time to dissolve, for it is a *sine qua non* of the method, that a large increase in the proportion of chlorine shall be made. The method further suffers from the fact, that if the

water issuing from the lower point is subject to contamination (obvious or otherwise) from animal sources, its chlorine-content will be variable and a wrong interpretation might therefore be placed on an increased chlorine content of the lower water. An inconvenience of the method is therefore that a series of determinations, extending over some days, of the chlorine in the water, must be made before the trial. On the whole, therefore, sodium chloride cannot be regarded as suitable for the purpose in view.

A lithium salt has been used for the purpose, and we might expect that it would be safer, because more characteristic, in its indications. I can see little objection to the use of lithium salts, although I believe that fluorescein will usually be found better. It is conceivable that the case might arise where coloration of the water was prohibited, either for aesthetic reasons or to avoid arousing suspicion, and in such instances, I think recourse might be had to a lithium salt. In passing, it may be noticed that lithium chloride, when present to the extent necessary for its easy recognition, is not poisonous. Lithium chloride was used by Frankland, in determining the source of the contamination of a Dublin water-supply, in an examination, which has since become classical.

Potassium, or sodium, permanganate has been suggested as a material to use: but as most natural waters exert some reducing power on permanganate, and as organic matter with which water might come into contact in the underground passage, would reduce the permanganate, this substance could only be of practical value where the underground channel is very short and fairly free from debris.

Other materials, which impart a distinctive colour to the water, have been used: I refer to the aniline dyes, and it is to one of these—fluorescein—that I desire here to make more particular reference.

Before discussing this matter, reference may be made to one other group of substances, which might be made use of in tracing water connections,—organisms or bacteria, not normally present in either of the two waters under investigation. The bacteria used must be non-pathogenic, and for ready recognition a pigmenting organism such as *B. prodigiosus* would be a convenience. If the connection between the two points were by a fairly clear channel, this method might be successfully employed, but if the water is passing through debris in the channel, this is liable to become an efficient bacterial filter for the time being and thus prevent the passage of the organisms. Furthermore, the possible effect of sedimentation, and the life of the bacteria in the water, would require to be taken into consideration, and finally, Busch (*Centralblatt f. Bakteriol.* II., vol. xvi., 119, 1906) has shown that the recovery of a bacillus, even in an open stream, at a point a mile or two below that at which the organism was added, is not always a matter of ease. In the tracing of underground waters, I do not think that great reliance can be placed on bacteria.

Fluorescein complies in a high degree with the requirements necessary in tracing underground waters. When fluorescein is dissolved in water—with the aid of a small quantity of alkali—the solution possesses a brilliant green fluorescence, which is destroyed by acids. The fluorescent solution is reddish by transmitted light. To the unaided eye the limit of visibility of the fluorescence is usually about one part in forty million parts of water. This must be taken only as an average, for with some specimens the fluorescence can be seen when an even greater quantity of water is used, but with other specimens the fluorescence would disappear to the unaided eye before quite such a high dilution is reached.

By the use of the Marboutin fluoroscope (*Comptes rend.*, 1901, vol. 132, 365), the fluorescence can be detected when the solution contains only one part in 10,000,000,000 of clear water. The Marboutin fluoroscope consists of a tube of pure white glass, 95 cm. long and about 1.5 cm. in diameter, which is closed at one end by a rubber stopper blackened with powdered plumbago. The solution to be examined is filled into this tube, which is placed in a vertical position; on looking down the tube, the fluorescein is recognised by the projection of a greenish reflection on the black stopper. Some experience is necessary to avoid confusion of the natural tint of the water with the green colour due to the presence of fluorescein, and unless the glass is well chosen, difficulty in recognising the proper green reflection is sure to arise.

Knipscher (*Pharm. Weekbl.*, 1906, vol. 42, 1,042) has successfully used a method of concentrating the fluorescein by absorption in animal charcoal, from which it can be dissolved out with a small amount of solution of an alkali. I have found this to be quite practicable inasmuch as by agitating about a litre of water, known fluorescence, with about two grams of animal charcoal (of good to contain fluorescein, but which to the unaided eye showed no absorptive power), and then treating the charcoal with 10 cc. of a 1% solution of caustic soda, a solution was obtained, which distinctly showed fluorescence. The method is, however, somewhat cumbersome.

I have found that the delicacy of the recognition of fluorescein can be increased almost at will by the simple process of evaporation. It is clear, that if a litre of water containing fluorescein be concentrated by evaporation down to 10 cc., the intensity of the fluorescence will be increased approximately 100 times, provided that no change takes place in the fluorescein. I have tried with several natural waters of different compositions, by taking 10 cc. of a solution of fluorescein, in which the fluorescence was just detectable, and diluting to two litres with such waters, then evaporating to about 10 cc., and in no case have I failed to obtain a solution which showed fluorescence. In practice I have found it convenient to take two litres of water, and concentrate to 5 cc. By this means, the delicacy of the recognition is increased 400 times, and thus, if two litres of water are available, fluorescein can be detected, if present, to the extent of 1 part in 16,000,000,000; *i.e.*, if there is only .000125 mg.

present. Hypothetically, the delicacy can be increased either by starting with a larger quantity or by concentrating further—but I do not desire to attach much importance to the quantitative relationship, for I find in practice that 2 litres is a sufficient quantity to take, and that it is not advisable to concentrate below 5 cc., otherwise the observation becomes difficult, and if the water contains dissolved matter, which may have separated on evaporation, the solid must be separated by filtration. 5 cc. occupies a convenient space for observation in a tube of rather less than 1 cm. in diameter. In order to ensure that the final solution is alkaline, it is always well to add a drop of ammonia solution, although this is usually unnecessary, particularly if the evaporation has taken place in a glass vessel. Should ammonia cause any precipitation, the precipitate must be removed by filtration.

I would particularly sound a note of warning that one must be on guard in observing the final solution, not to mistake a greenish colour, which often results on the evaporation of water, for the coloration due to fluorescein. If iron is present in the water, this greenish tinge is likely to be obtained. It is, therefore, advisable, at any rate until some experience is gained in distinguishing the colours, to compare the evaporate with water to which a minute trace of fluorescein has been added.

Absorption of Fluorescein.—The absorption of fluorescein was first noticed by Trillat (*Bull. Soc. belge geol.* 1903, 17, 301). He states that a large amount of calcareous matter in solution (especially the carbonates), will decolorise the dye to some extent. This, however, was not the experience of Dr. Copeman, who in connexion with the investigation for the Local Government Board, on an outbreak of enteric fever at Fulbourn Asylum, near Cambridge, was led to endeavour to trace the contamination of a hard underground water by means of fluorescein, and who passed a solution of fluorescein through columns of chalk, without observing any diminution in the intensity of the colour. (Report of Medical Inspectors of the L.G.B., No. 229, 1906).

From some preliminary work it had been found that on passing a 1 in 550,000 solution of fluorescein in water through a column of soil, the fluorescein was at first completely removed, but as filtration proceeded, the filtrate was found to contain fluorescein, and ultimately the solution passed through undiminished in fluorescing power. Prolonged percolation of water showed that the fluorescein could be completely washed out of the soil. By substituting a fine-grained sand for the soil, exactly the same phenomenon was observed, and further, it was found that precisely the same results were obtained, when use was made of a solution of fluorescein made alkaline with sodium hydroxide.

In order to ascertain if the extent of the removal of the fluorescein from solution was proportional to the amount of sand through which the solution filtered, three tubes of the same internal diameter (1.9c.m.) were fitted with stoppers through which passed narrow glass tubes. A layer of coarse gravel—about 3 cm. deep—was placed in

each tube, and on this were placed columns of fine sand, respectively 7, 14, and 27 cm. in length. These tubes were set vertically, and flasks, containing a solution of one part of fluorescein in 200,000 of water, were arranged over them, in such a way that the solution was delivered into the tubes about 7 cm. above the surface of the sand; the level and hydrostatic pressure were therefore constant throughout the filtration, and approximately the same in each tube.

The following table shows the results:—

Length of sand column	7 cm.	14 cm.	27 cm.
Time taken from starting filtration until first drop fell from the narrow tube	17 min.	35 min.	90 min.
Volume of filtrate before florescein made its appearance evident...	9 cc.	17 cc.	36 cc.
Time taken for the solution to pass through unchanged (estimated approximately)	115 min.	180 min.	350 min.

These results indicate that the amount of fluorescein removed was proportional to the amount of sand with which the solution came into contact, and taken in conjunction with the fact already established, namely, that the removed fluorescein could be washed out of the sand, suggests that the florescein is mechanically adsorbed by the sand or soil, and probably the adsorption proceeds until an equilibrium is established between the concentration of the fluorescein in the film adhering to the surface of the grains, and that in the bulk solution. This view—that the phenomenon is a surface one—is supported by the fact that when coarse sand (presenting a smaller surface) was used, a smaller amount of florescein was adsorbed. The process would appear to be comparable with the dyeing of wool with substantive dyestuffs.

In connexion with the use of fluorescein for detecting a water contamination, it has been suggested that the method is of little use, because it does not follow that bacteria can go where fluorescein can. But this is an objection, which, if valid, applies with equal force to all methods wherein the contaminating connection is sought by means of any substance in solution (cf. P. F. Frankland's method with a lithium salt).

In so vital a matter as a water-supply therefore, I hold, that if a connection can be established by means of fluorescein, between a spot known to be contaminated and the source of the water-supply, such supply should be regarded as dangerous, and liable at any time to give rise to a water-borne epidemic.

In view of the adsorbing action which soils and sands have been shown to exert on fluorescein, it seemed desirable to ascertain if bacteria would percolate through a column of soil in a similar manner to fluorescein.

A preliminary experiment with an organism of the *B. prodigiosus* group, led to no satisfactory result, but more success was obtained

with a good pigment-forming strain of a green, very motile organism, closely akin to the *B. pyocyaneus*. A number of trials showed that this organism could be easily recovered, both from distilled and tap water, even after some days, and as the presence of fluorescein did not interfere with its recovery, the organism was suitable for the purpose, and the following experiments were carried out:—

A tube, similar to that previously described, was prepared with a column of fine sand, 7.5cm. in length, and the sand, apparatus, etc., having been found free from the pigment-producing organism, 50 cc. of a 0.02% solution of fluorescein was made up to 1,000 cc. with distilled water, to which a small quantity of an agar growth of the organism had been previously added, and incubated for 24 hours: the solution was fed on to the sand as in previous experiments.

Sixteen minutes elapsed before the first drop fell from the tube, and the green organism was present from the beginning and all through the experiment, whereas it required about an hour before (in the 19th cc.) the fluorescein solution came through, apparently unchanged.

An experiment carried out similarly with the same material, but with a column 32cm. long, gave the same results: 69 minutes elapsed until the first drop fell from the narrow tube, and the green organism was present at once, but the fluorescence only appeared after some 25cc. had passed.

After complete draining, water was added, and the green organism was found in the 7th cc. of the washing, showing that, although the experiment had lasted some days, the sand column had not become a filter for the organism.

The same result was obtained with a column of sea-sand, 32cm. long, and also with a 32cm. long column of a very sandy soil.

A black loamy soil (from Potchefstroom) was next tried. Through a column, 32 cm. long, the percolation was very slow, 6 hours and 43 minutes elapsing before the first drop fell. Contrary to expectation, however, the first drop showed a very faint fluorescence. The faint coloration persisted for a considerable time without apparently becoming more distinct; after about 20 cc. had passed through, the intensity of fluorescence began to increase, and after about 50 cc. had percolated, the intensity was about as great as in the original solution. There appeared in this case to be a slight filtering action with respect to the organism, for on "plating" the first cc., the pigment did not show until considerably after 24 hours' incubation. This may, however, have been due to the presence of some substance extracted from the soil (humic acid?), inhibiting the growth or pigmenting power of the organism. The organism was similarly found in the 11th cc. and in the 30th cc., showing on agar after 24 hours incubation.

These results, and particularly those noted in connexion with adsorption, indicate that fluorescein must not be expected to appear in a time proportional to the rate of flow, when the water has to

percolate through soil, gravel, sand, or detritus. Its appearance will be the longer delayed, the finer the material through which the water passes.

In reply to Dr. Moir, the author mentioned that he had succeeded in establishing, by means of fluorescein, the connection between two surface waters four miles apart, although only about an ounce of fluorescein was available at the time.

3—STANDARDISATION OF COAL ANALYSIS.

By H. H. C. Puntan, F.C.S.

I wish to put before you a plea for a uniform method or standard for the sampling and analysis of coal, and have pleasure in suggesting a working standard, which, if generally adopted, would, in my opinion, greatly tend towards concordance of results.

Sampling is usually done in a very haphazard manner at the mines, and I feel sure that many conflicting analyses made by different operators are more often due to defective sampling, than to defective analysis. However accurately the analysis may be made, if the sample is not representative, the result is worthless.

I have now for some considerable time been using the method adopted by the Committee of the American Chemical Society, and with slight amendments in working details, find the method to give wonderfully concordant results. The necessity for a standard method of analysis is very obvious, when we consider, that the results we obtain for moisture, volatile matter, and fixed carbon, depend wholly upon personal equation, as the usual methods are more or less conventional and arbitrary, with no agreement as to details, and it is only by very strict attention to details, that work by different operators will give concordant results.

The working details for a standard method would be as follows:

Preparation of Sample.—As soon as the coal is received, crush it up and quarter down to about 100 gram. Grind this up as fine as possible in an ordinary coffee mill, and keep in stoppered bottle. Grind about 15 grams of this to pass through a 60 sieve, and also transfer to a stoppered bottle.

Moisture.—Dry one gram of finely powdered coal in a platinum dish in a water bath for exactly one hour. For the Transvaal, I would suggest, owing to higher elevation and lowering of boiling point, that it should be dried in a bath of pure toluene, which boils in Durban at 105°C., but would in the Transvaal approach the temperature obtained by a water bath in Durban.* Cool and weigh quickly.

Volatile Combustible Matter.—Place 1 gram of finely powdered coal in a weighed platinum crucible, with a fairly tight lid, upon a platinum or pipe-clay triangle, and apply the full flame of a bunsen burner for exactly seven minutes. I have found seven minutes for Natal coal to give the most concordant results. The full flame of the burner should be about 20 cm. high, and in use should be about 8 cm. above top of burner. The upper surface of the lid should burn clear of carbon, but the under surface should remain covered with carbon. Draughts are to be avoided.

Ash.—Burn the portion of coal used for moisture determination at first over a very low flame, with crucible open and inclined, till

* *Pure* toluene boils at 111° at sea level.—Ed. Ccmm.

free from carbon. Examine ash for carbon, by moistening with alcohol, and re-heating if necessary.

Total Sulphur.—Determine by Eschka's method as follows:—

Weigh out 1 gram of finely powdered coal into a platinum dish of 70 to 100 cc. capacity, and add 1.5 gram of an intimate mixture of 1 part dry sodium carbonate and 2 parts light magnesium oxide.

Mix the coal with this mixture intimately, using a platinum spatula, and heat at first very cautiously, raising the temperature very gradually. When the strong glowing has ceased, increase the heat until in about 15 minutes the bottom of the dish is at a low red heat. During the latter part of the operation, stir occasionally with spatula. When all the carbon is burned off, cool and transfer the residue to a beaker. Rinse out the dish into a beaker with 50 cc. water and 15 cc. of saturated bromine water, and boil for 5 minutes. Treat the insoluble residue twice with 30 cc. of water, boiling each time, and finally transfer residue to filter, and wash until only a faint opalescence is given with nitric acid and silver nitrate.

Add to this filtrate, which should have a volume of about 200 cc., 1.5 cc. of hydrochloric acid, and boil until bromine is expelled. Now add to the boiling solution 10 cc. of a 10% solution of barium chloride. This should be added drop by drop, especially at first; with constant stirring, allow to stand upon a hot plate, when it will soon get perfectly clear. Then filter off barium sulphate, and wash with hot water until free from chlorides. Transfer the filter, and moist precipitate to the lid of a platinum crucible, and heat with a low flame, until the paper is burned. Finally heat to redness, cool in dessicator, and weigh. A blank determination should always be made, using all the reagents in the same quantities, and carrying out the entire process in exactly the same manner as with the coal.

Calorific Power.—The Lewis Thompson Calorimeter has the advantage of simplicity, but the results obtained even from the same coal are often erratic, and frequent trouble is causd by unconsumed carbon. Still it has the great advantage of simplicity of manipulation.

While admitting the much greater accuracy of the bomb calorimeters using compressed oxygen, I fear their use here would be too expensive for a technical use. A united opinion, as to the most suitable calorimeter to be used and to the type of coal used for standardisation, would be desirable.

In the discussion on the paper, Mr. J. Roberts said:—

It seems to me to be highly desirable that coal testing should be put on a better basis than it is at present. As a user of coal, I have found that published analyses of the same coal showed great discrepancies: especially in regard to the quantity of volatile matter, there seemed to be great uncertainty, and the amount of volatile matter is most important to any coal consumer who studied boiler economy; a coal higher in volatile matter requiring different methods

of burning to one of an opposite character. The secret of the trouble was probably improper sampling. The seams of coal in Natal are unusually intermixed with bands of shale or half-burnt coal, and consequently the excellence of, say, a hundredweight or a ton sample depends upon the care with which this inferior coal has been picked out. The sampling is just as important as the actual analysis, and before the final quantity is taken from the larger bulk sample, the latter should be crushed to the size of about, say, small nuts and graded according to its specific gravity.

I am aware that shales and half-burnt coal vary greatly, and results of specific gravity would not fairly compare one class of coal with another, but it would be the best guide as to whether the sample from any particular colliery was a fair one. The matter is one calling for attention most urgently, at the present time.

Consumers of coal in large quantities would view coal tests submitted by collieries with much greater confidence, if these tests were carried out in a central institution. In fact, the whole question of both coal sampling and coal testing, is one which calls out for attention, and is a work which should be undertaken immediately by such an institution, and would provide occupation for many months of exhaustive investigation.

Natal and South African coals seem to differ in many important respects from other coals, and I believe that the present methods used for coal analysis in England might be subjected to considerable modification in their application to the investigations of the qualities of local fuel.

Mr. Carl Hall and Dr. J. Moir also contributed to the discussion.

4—SOME PROBLEMS IN NATAL COAL-MINING.

By W. J. Heslop, M.I.M.E., F.G.S.

[Abstract.]

Occurrence of vertical and horizontal intrusion of dolerite is a marked feature; the influence of these has altered fully three-fourths of the Natal coal from bituminous to semi-anthracitic; vertical dyke influence generally local, horizontal dyke influence extensive.

Demand for semi-anthracitic coal small, since ash-contents higher than Welsh anthracite.

Natal coal of the bituminous character is of good quality, and has a large demand.

Immediately after the late war, native labour was scarce. Colliery owners were compelled to adopt mechanical coalgetters, and many types were tried: as the coal is mainly worked with bud and pillar system, the percussive type of coalgetter is most in favour, but at one or two collieries, chain cutting and rotary bar machines are used.

The author considers that the proportion of coal mining by mechanical coalgetters is higher than in any other country.

Surface handling of the coal calls for first-class plants for screening, sorting and washing the smaller grades.

Labour employed is European as supervisors, but natives and imported Indian coolies for the ordinary unskilled work.

A trial is being made at one colliery of establishing a native village near the mine, so that the workers may have their families near them; it is hoped thereby to secure continuous work from the "boys," as natives are usually called.

5—GEOLOGICAL NOTES ON THE COAL AND GOLD DEPOSITS IN NATAL.

By C. J. Gray.

Coal occurs in almost every part of the Colony, the seams being of two ages. Mr. Anderson, lately Government Geologist of Natal, has pointed out* that the coal in the Drakensberg in the Polela division (being accompanied by a Thinnfeldia fossil flora) is of Stormberg age, and more recent than the other coals, which go with a Glossopteris flora. This Stormberg seam is about 5,750 feet above sea level, and the actual coal, which is little more than 2 feet thick at the best exposures, is very bituminous near the headwaters of the Umkomaas, and there grades into bituminous shales, but it becomes more anthracitic and unaccompanied by shales to the southward.

Mr. Anderson classes the lower and far more important seams in the Ecca series, including in that term, the Glacial Dwyka Conglomerates; the dark-coloured non-fossiliferous Pietermaritzburg shales lying immediately above the Dwyka; the light-coloured shales and sandstones forming the upper portion of the Pietermaritzburg shales; and the still higher sandstones and shales containing abundant Glossopteris and some reptilian remains in which the coal seams occur. The series is separated from the Stormberg beds by the Beaufort claystones, fine grained sandstones and shales, containing more abundant reptilian remains.

It has been my practice to divide the series into three divisions, viz., the Dwyka, the Ecca shales, and the Natal Coal Measures, and I consider that those divisions should be recognised in all geological mapping and other geological work in the Colony. The divisions are distinct in petrological character, and for that reason can be readily distinguished in the field. The coal measure shales generally show remains of fossil flora, while the Ecca shales do not show such remains, though in places they contain thin and valueless anthracite seams and graphitic beds. Even in hand samples the distinction can generally be made with some approach to certainty, as the coal measure shales are as a rule less dense in texture, and either more sandy or micaceous than the older shales. From the economic point of view their recognition is of great importance, as the economic products (either minerals or building stones) of the different divisions; their characters affording water supply, the soils resulting from their weathering; and their influence on topography; all differ greatly.

I do not urge that the terms which I use to indicate the divisions are the best, or undoubtedly correct. The apparent absence of fossils in what I call the Ecca shales may indicate that the class is older than the Ecca shales of the Cape Colony, and would be more correctly termed the Dwyka shales. The shales, though nearly 1,000 feet thick at Maritzburg, thin out inland, so that they are only a few

* Second Report. Geol. Survey of Natal.

feet thick, or, according to Dr. Molengraaf,* entirely absent, in some places near the northern border of the Colony. This thinning in some degree supports the idea that they are Dwyka shales, and is of interest in connection with the close association of coal seams with the Dwyka conglomerate at Vereeniging. The term Natal Coal Measures, though locally useful, is thus not quite suitable for a series which is important, and contains valuable coal seams, far outside the Colony. It may be desirable to say that though adopting the Ecca correlation, I do not definitely decide on the doubtful question as to whether the Natal Coal Measures should be placed in the Ecca or the Beaufort series, but I consider that in either case they should be named, studied and mapped as a separate division.

We now turn to the consideration of the distribution of coal in the Natal Coal Measures. Speaking generally, and without regard to local washouts and igneous intrusions, it may be said that except to the west of the railway line from Harrismith to Durban, and in Durban and Victoria Counties, we find coal, in seams over a foot thick, wherever the proper horizon in the coal measures is pierced, but elsewhere the measures do not show any important seams.

On the farm "Magnolia,"† on the high ground between Greytown and Reitvlei, the outcrops of six thin seams are exposed, the thickest seam at the place containing 1′ 5½″ of coal. It is about 4,030 feet above sea level. On the farm "Pampoen Nek," in the same neighbourhood, where the principal coal seam is thicker, a borehole§ 459 feet deep has been put down beneath the seam, proving alternate beds of sandstone and shale belonging to the coal measures to a depth of about 400 feet, where the Ecca shales were apparently reached.

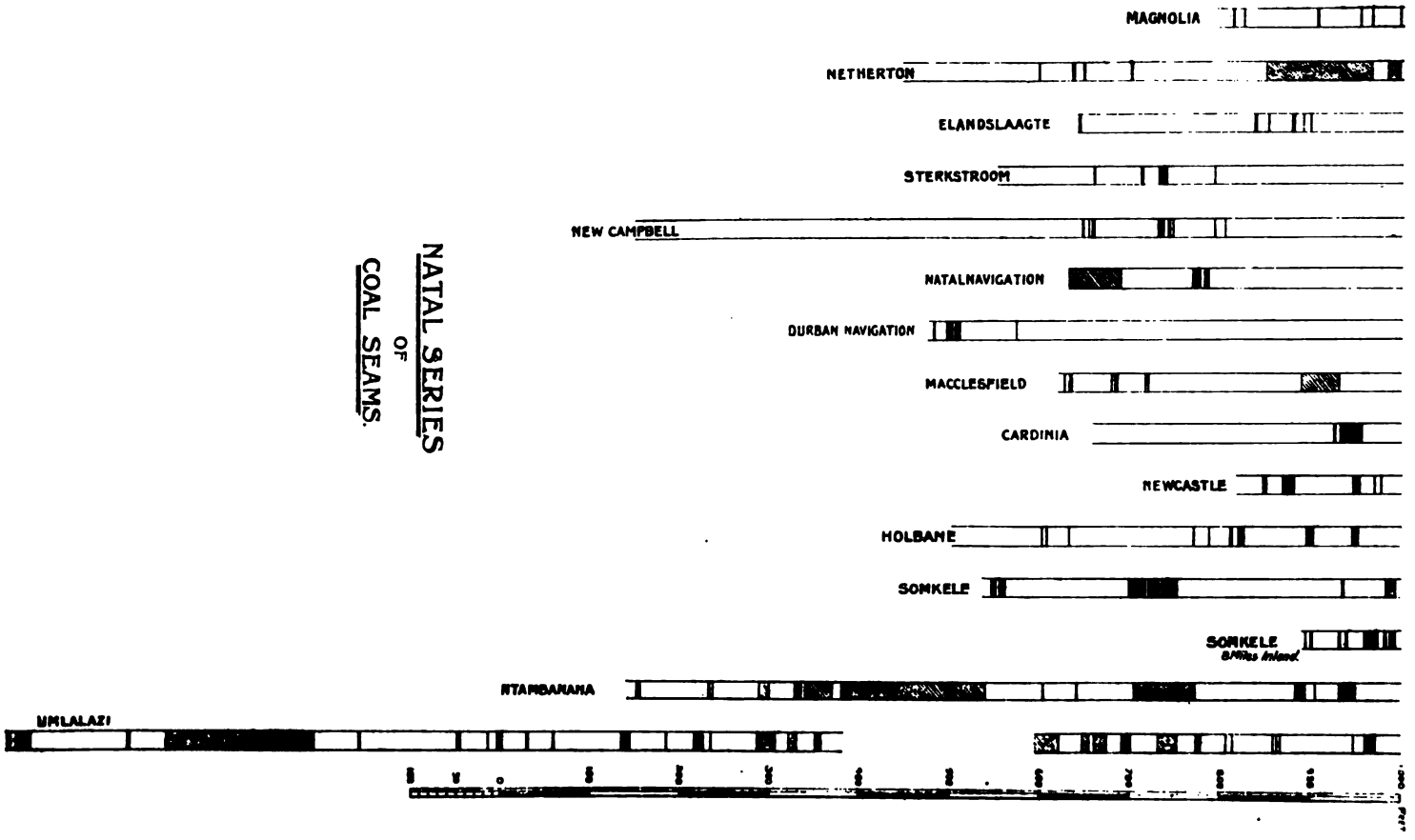
To the north-west of the Greytown Coalfield, in the neighbourhood of Mooi River, Willow Grange, Estcourt, and Frere, numerous thin seams outcrop, but none have yet been proved to be of value, though much drilling has been done in search of payable seams. Probably each of the boreholes mentioned, with the exception of that at Mooi River, is entirely in the coal measures. The published section of the Mooi River borehole is unreliable, owing to a misleading use being made of the term "Boulder clay." From examination of the ore it appears to me probable the Ecca shales were reached at a depth of about 950 feet, that is, about 900 feet below a thin coal seam pierced by the bore.

Between Colenso and Pepworth stations the coal measures are absent, the Ecca shales being exposed owing to a great upthrow of a strip of the strata, the vertical displacement being probably not much less than 1,000 feet. The southern fault probably runs along the Tugela Valley near Colenso, turning off near Spion Kop towards Harrismith, and passing a little to the east of Acton Homes. The northern fault runs from about three-quarters of a mile south of

* Geological Survey Report, S.A.R., 1898.

† Mines Department Report, Natal, 1898.

§ Vide Mines Department Report, Natal, 1898.


NATAL SERIES
OF
COAL SEAMS.
MAGNOLIA
NETHERTON
ELANDSLAAGTE
STERKSTROOM
NEW CAMPBELL
NATALNAVIGATION
DURBAN NAVIGATION
MACCLESFIELD
CARDINIA
NEWCASTLE
HOLBANE
SOMKELE
SOMKELE
8 Miles Inland
NTAMBANANA
UMLALAZI

Pepworth station across the farm "Burford," near the sharp southerly bend of the Klip River. Beyond that fault a strip is met with which has been dropped about 500 feet, the differential movement on the fault being therefore approximately 1,500 feet. On crossing the fault, the coal measure sandstones suddenly appear on the surface, while several boreholes, among which may be mentioned one on the farm "Netherton," have passed through the coal seams at heights above sea level of about 3,050 feet.

Near Elandslaagte, the northern side of the depressed strip is reached, and at the Elandslaagte Colliery coal outcrops, the seams being respectively 3,538 feet and 3,529 feet above sea level. From boreholes put down at Elandslaagte, and the Ramsay Colliery near Wessels Nek, it is clear the lower seam must be more than 700 feet above the Ecca shales. To the north of the Biggarsberg the seams are observed to be closing together. Near Glencoe Junction, on the farm "Sterkstroom," the two principal seams are 15 feet apart; at the Woodlands Colliery, between Glencoe and Hatting Spruit, 5 feet; and at the Durban Navigation Colliery, near Dannhauser, 1 foot 6 inches.

North of Dannhauser the sections of the coal seams and the associated strata become very variable, widely different results being obtained in boreholes relatively close to one another. As a generalisation, it may be said that there we usually find two seams, one thick and the other thin.

It is clear that both at Hatting Spruit and Newcastle the coal seams are far from the base of the coal measures. At the Woodlands Colliery (formerly New Campbell) a borehole has passed 500 feet below the seams without reaching the Ecca shales, while on the farm "Johnstone," between Newcastle and Utrecht, a borehole at a lower geological horizon than the coal, has gone down 600 feet in coal measures, apparently reaching the Ecca shales at about that depth. In the Utrecht and Vryheid districts the seams vary in section as they do near Newcastle, but as a rule not quite so rapidly. They are more numerous than on the Klip River field. The lowest seam at Hlobane is 4,030 feet above sea level, and about 400 feet above the Ecca shales, and as the latter are thin there, little more above the Dwyka. Little is known of the seams near Nongoma up to the present.

The coal seams so far referred to lie almost horizontally, but when we come to Somkeli, on the Zululand coast, we meet with a different condition of things, for there the strata dip at an angle of 20 to 30 degrees to the south-east. It appears probable that the parallel lines of outcrop of thick seams which are found on the Somkeli Coalfield do not represent originally separate seams, but are due to step faulting. About 8 miles inland from Somkeli we have a section showing several seams, while other seams not yet correlated outcrop there. A borehole at the Zululand Colliery, near Somkeli Station, shows a very thick seam and a thinner seam lower down. In the diagram correction has been made for dip. The

outcrop of the thick seam is 300 feet above sea level. If we take the shale exposed to the north of the Somkeli outcrop and reached by boreholes below the seam to be the Ecca shales, as is probable, the lowest seam must be approximately 275 feet, measured at right angles to the dip of the strata, from the base of the coal measures.

At Ntambanana, a seam, in some places as much as 7 feet thick, but seen to thin elsewhere, is opened by adits. Its relation to other seams is not clear. No other outcrops are exposed, and boreholes put down in flat country in the direction of the dip, which is slight, have shown thin seams only. Ecca shales and Dwyka outcrop inland, a few miles from Ntambanana, on the Melmoth road, but it is difficult to estimate the perpendicular distance between the thick coal seam and the base of the coal measures. It is, however, considerable.

The Umlalazi Coalfield, which is on the southern side of the granite belt forming the Ungoye Range of mountains, is very different from the other coalfields in the Colony. The seams are very numerous. As the ground is much broken and tilted, and the seams variable in section, correlation is difficult. I can make no attempt to place the numerous outcrops on the northern side of what is known as the Ibade Stream, but from two borehole sections on the southern side of the Ibade, I have compiled a section showing numerous seams varying from an inch or two up to 8 feet in thickness. The lowest seam shown, is, probably, judging from a borehole behind the outcrop which has passed into the shales, about 900 feet from the Ecca shales.

The character of the coal in the Stormberg seam has already been referred to.

ANALYSES OF NATAL COAL.

(1) STORMBERG SEAM.

	At Umkomaas River.	At Garden Castle.
	%	%
Moisture	1.42	1.59
Volatile Hydrocarbons ...	33.39	15.03
Fixed Carbon	39.96	52.23
Sulphur	1.11	2.26
Ash	24.50	29.65
Specific Gravity	1.472	—
Ratio Fixed Car. to Vol. Hydrocarbons ...	1.2	3.4

For the Ecca seams we may generalise by saying that apart from local variations the seams are most bituminous near Newcastle.

My remarks are based almost entirely on analyses published either with the report of the Government Coal Testing Committee,

1904-5, or in the various Mines Department reports, but I have made use of a few unpublished analyses, giving some in the table, while others, not available for publication, have assisted me in checking the accuracy of my generalisations. I have avoided analyses representing coals known to be locally affected by igneous intrusions. The samples, on which the analyses are based, were so taken that they represent the commercial product of the seams, and not specially picked coal.

(2) ECCA SEAMS.

	Newcastle Colliery. %	No. 42 Colliery. %
Moisture	2.60	2.03
Volatile Hydrocarbons ...	28.96	25.65
Fixed Carbon	56.10	56.37
Sulphur	1.23	1.98
Ash	11.52	14.65
Specific Gravity	1.388	1.440
Ratio Fixed Car. to Vol. Hydrocarbons	1.9	2.2

	Durban Navigation Colliery. %	Natal Navigation Colliery. %
Moisture	1.50	1.16
Volatile Hydrocarbons ...	29.06	19.90
Fixed Carbon	57.63	67.82
Sulphur	1.20	1.58
Ash	11.02	10.08
Specific Gravity	1.363	1.342
Ratio Fixed Car. to Vol. Hydrocarbons	1.9	3.4

	Glencoe Colliery. %	Natal Merthyr Colliery. %	Central Colliery. %
Moisture	1.15	1.35	2.00
Volatile Hydrocarbons ...	18.75	19.39	15.87
Fixed Carbon	66.69	64.10	67.94
Sulphur	0.97	2.60	1.87
Ash	12.82	13.34	12.96
Specific Gravity	1.389	1.428	1.404
Ratio Fixed Car. to Vol. Hydrocarbons	3.5	3.3	4.2

	Elandslaagte Colliery.	Elandslaagte. Bottom Seam.	Swaartz-kloof.
	%	%	%
Moisture	1.00	0.95	1.40
Volatile Hydrocarbons ...	22.54	22.06	21.40
Fixed Carbon	56.90	60.00	49.40
Sulphur	1.60	2.57	1.04
Ash	18.50	15.20	27.32
Specific Gravity	1.427	1.367	1.385
Ratio Fixed Car. to Vol. Hydrocarbons	2.5	2.7	2.3

	Magnolia.	Uitzicht.	Utrecht.	
	%	%	%	%
Moisture	1.89	1.49	2.90	1.82
Volatile Hydrocarbons ...	6.05	9.01	24.64	24.20
Fixed Carbon	71.14	71.94	64.20	65.21
Sulphur	3.44	2.95	1.00	1.24
Ash	16.43	14.02	7.60	7.95
Specific Gravity	1.603	1.641	1.345	1.378
Ratio Fixed Car. to Vol. Hydrocarbons	11.7	8.0	2.6	2.2

	Makatese Kop.	Paulpietersburg.
	%	%
Moisture	1.80	3.59
Volatile Hydrocarbons ...	23.43	16.03
Fixed Carbon	65.89	67.56
Sulphur	1.03	1.52
Ash	8.20	11.82
Specific Gravity	1.326	1.423
Ratio Fixed Car. to Vol. Hydrocarbons	2.8	4.2

	Hlobane "Homestead."	Hlobane "Tnick,"	Hlobane "Tonkin."
	%	%	%
Moisture	1.04	0.40	0.65
Volatile Hydrocarbons ...	16.00	17.71	19.55
Fixed Carbon	69.53	68.84	70.58
Sulphur	0.48	0.38	0.37
Ash	13.10	12.86	9.04
Specific Gravity	1.434	1.464	1.347
Ratio Fixed Car. to Vol. Hydrocarbons	4.3	3.8	3.6

	Vaal-bank.	Nongoma.
	%	%
Moisture	1.60	5.09
Volatile Hydrocarbons ...	15.19	10.29
Fixed Carbon	71.74	80.53
Sulphur	0.65	1.14
Ash	11.08	2.95
Specific Gravity	1.396	1.57
Ratio Fixed Car. to Vol. Hydrocarbons	4.6	7.8

	Seams 8 miles inland from Zululand Colliery.		
	%	%	%
Moisture	15.35	1.75	10.10
Volatile Hydrocarbons ...	20.14	6.75	19.71
Fixed Carbon	41.47	61.91	52.96
Sulphur	0.73	2.62	0.37
Ash	22.44	28.89	17.04
Specific Gravity	1.600	1.546	1.562
Ratio Fixed Car. to Vol. Hydrocarbons	2.0	9.2	2.7

	Zululand Colliery.		
	%	%	%
Moisture	2.46	2.00	1.8
Volatile Hydrocarbons ...	7.38	6.37	6.60
Fixed Carbon	75.12	81.47	75.20
Sulphur	0.58	0.39	0.66
Ash	15.04	10.16	16.30
Specific Gravity	1.51	1.47	1.55
Ratio Fixed Car. to Vol. Hydrocarbons	10.1	12.8	11.4

	Ntambanana.	Bottom thick seam, Umlalazi.
	%	%
Moisture	1.26	9.62
Volatile Hydrocarbons ...	13.10	17.78
Fixed Carbon	65.59	53.10
Sulphur	—	0.21
Ash	19.62	19.40
Specific Gravity	—	1.587
Ratio Fixed Car. to Vol. Hydrocarbons	5.0	2.9

Generalising, it may be said that about Newcastle and Dannhauser the ratio of the unaltered coal is 2; in the Hatting Spruit, Dundee and Wessels Nek districts, 3.5; somewhat less, say 2.5, about Elandslaagte, while on the Greytown Coalfield the coal is anthracitic, the ratio being about 10 to 1.

It may be said that in the Utrecht district the ratio is about 2.5 to 1, and near Hlobane about 4.0.

About Somkeli nearly all the coal is anthracitic, and the ratio may be put at 10, but 8 miles further inland, where the limit of the decidedly tilted strata is reached, semi-bituminous coal has been found. At Ntambanana the ratio is about 5 to 1.

As regards ash it may be said that on the Klip River Coalfield from Newcastle to Wessels Nek the percentage is about 12, but at the southern end of the coalfield, Wessels Nek and Elandslaagte, where a few collieries work the upper seam, the percentage is somewhat higher. On the Greytown Coalfield there is about 15 per cent. of ash. In the Utrecht district the coal is exceptionally clean, the figure being about 8, while in the Vryheid district the average may be put at 12, the same as on the Klip River Field. From Nongoma we have a sample giving a lower percentage of ash than any other South African coal I am aware of. At Somkeli the average may be about 15.0. On the Ntambanana and Umlalazi fields the coal is usually very dirty.

It seems clear, when consideration is given to the way in which the carbon ratios and the percentages of ash and sulphur change as the seams are followed from district to district, that there have been general influences affecting the seams over large areas, apart from purely local influences such as igneous intrusions. Probably those general influences, at least in the Klip River, Utrecht, and Vryheid districts, were original, that is to say, attendant on the conditions of deposition.

On the Zululand coast the pressure and perhaps heat accompanying tilting and faulting of the strata observed in that portion of the Colony probably have affected the seams.

Near Greytown the alteration is not improbably due to pressure also, though the seams are nearly horizontal, as the conditions appear to resemble on a large scale those observed on a small scale at the Impati Mountain, near Dundee. In that isolated mountain the coal seams lie almost horizontally at a level about 300 feet higher than the same seams in the surrounding country. It seems clear from inspection of the slope between the seams and the dolerite sheet forming the top of the mountain, that the overlying dolerite is too far above to account for alteration of the coal, and while a borehole put down to a depth of 156 feet below has shown no igneous rock, yet the coal is anthracitic, the ratio of fixed carbon to volatile hydrocarbons being 10.6 to 1. I attribute the alteration of the seams to the pressure which has raised the mountain and seams above the surrounding country.

GOLD.

I will now pass on to deal very briefly with the deposits of gold in the Colony. Though up to the present that metal has not been worked successfully on any large scale, it is very widely distributed, and I am sure that sooner or later profitable mines will be established. It will be seen that the deposits are most abundant in North-Western Zululand, that is, approximately, in the centre of the Colony.

I have had reliable information as to the occurrence of gold in practically every geological formation in Natal, from the Gneiss to the Stormberg beds, but the most important known deposits are in either granite or gneiss, the Swaziland schists, the Witwatersrand series, the Black Reef series, or the Table Mountain sandstones.

GOLD IN GRANITE AND GNEISS.—A belt of granite and gneiss extends from near Port Shepstone through Botha's Hill, on the railway, into the Eshowe district of Zululand, and through the Unjoye Mountains to the sea coast. Another belt passes northward from Zululand through the Babanango Division and under the Vryheid coal measures to Luneberg, on the Transvaal border. It is probable that the gneiss is the oldest formation in the Colony, although the fact is obscured owing to the gneiss being locally altered into granite, which is in places extruded into the Swaziland schists.

Gold, in quartz reefs in the gneiss, is now receiving attention near Umzinto, and near Mpapala, in the Eshowe district. At Dumisa, near, Umzinto, several thin rich quartz leads occurring in a sheared belt of hornblendic gneiss are being mined, and near Mpapala large reefs cased in granite are being opened up. In connection with the Dumisa reefs it may be noted that the quartz contains a large proportion of marcasite, some at least rich in gold.

A few miles from Dumisa, a gold-bearing quartz reef, known as the Happy Thought, formerly worked by the Natal Gold Mining Company, is interesting in view of the theory as to the connection of some gold reefs with granitic extrusions, as the reef contains felspar and mica. Pockets of clay rich in gold have been found overlying the gneiss in several places, having no possible apparent connection with any quartz reef. At Signal Hill, near Eshowe, the gold found in the surface soil is in the form of wire gold.

SWAZILAND SCHISTS.—The Swaziland schists do not appear in Natal proper, except close to the Zululand border, but in Zululand and in the Northern Territory they are found flanking the gneiss.

Gold is very widely distributed in the schists, as, for instance, in the Tugela Valley, the Lower Insuzi Valley, and the Vungwini Valley, and near Melmoth, Nondweni and Paulpietersburg.

The schists are mostly fine grained and chloritic, but sometimes, especially near the gneiss, they are courser and hornblendic. The variety in character of the gold-bearing reefs in schist is so great that it is impracticable to do more than refer to a very few examples. Household's Reef, near the junction of the Buffalo and Tugela

rivers, consists of a series of quartz bodies in a particularly distinctly laminated layer of chloritic schist. The quartz bodies are lenticular in horizontal section, but are apparently elongated in depth, resembling crooked, flattened columns. No doubt the reef follows a line of shearing parallel to the foliation of the schist. The Phœnix Reef, lower down the Tugela, is similar in character to Household's, but the casing is a coarser hornblende schist. The Enterprise Reef, at Nondweni, so far as it has been opened, consists of one large lens of dark bluish glassy quartz as much as 26 feet thick at one place. It has been driven along for a distance of 740 feet, which is probably almost the full length of the lens. It appears most probable that the reef lies along a line of shearing which has been opened by subsequent end pressure on the strata. The Sisters Reef at Nondweni is of a different type, lying as it does along the under side of an interbedded basic dyke. Most of the quartz veins in the schists appear to owe their origin to the opening of the folia of the schists, by either end pressure or folding.

What is known as the "Sisters Hill formation" is of special interest to the geologist. It crops out as a great bed or vein in the schists, with a width at one place of as much as 120 feet, and consists mainly of silica and carbonate of iron, with some chlorite. Numerous small and irregular quartz veins, many of which are rich in gold, ramify through the body, converting it into a "stockwerke." Though the unweathered rock is extremely hard, it weathers very rapidly, leaving a network of quartz veins standing.

WITWATERSRAND SERIES.—The strata which I believe belong to the Witwatersrand series are exposed (1) in the Buffalo Valley, a short distance above its junction with the Tugela; (2) in the upper portion of the Insuzi Valley, in the Umhlatuzi Valley, near Nkandla, in the valley of the Pongola River, near Paulpietersburg and Louwsburg, and in a few smaller areas elsewhere.

The series consists, in the Colony, of alternating beds of quartzite and schist with occasional beds of gold-bearing conglomerate. The beds are invariably much folded, with the axes of the folds running approximately east and west. The reasons, apart from authority, leading me to place the beds in the Witwatersrand series, are:—

1. The relation to the Swaziland schists which frequently underlie them, and to the Table Mountain sandstone and Dwyka conglomerate which in different places overlie them directly, but unconformably.

2. Their petrological character.

3. The absence of granite intrusions.

4. The presence of dykes exactly similar to the older dykes on the Witwatersrand.

5. The presence, in the lower portion of the series, of beds containing much magnetite and similar in character to the Hospital Hill shales.

6. Their age, which is appearently greater than that of less completely metamorphosed and little-folded beds containing gold-bearing banket, which may correspond to the Black Reef series.

7. The presence of gold-bearing bankets.

On the Upper Insuzi Goldfield, studied by Mr. J. S. Hedges, of the Natal Mines Department (see Mines Department Report, Natal, 1903, it may be remarked in passing that on the Insuzi Goldfield and elsewhere in Natal, there are no anticlines in the Witwatersrand series, the synclines butting against one another along lines of faulting. It is not certain what relation the beds exposed in the three synclines have to one another, but it seems probable that those in the Upper Insuzi syncline are the oldest, and those in the two other synclines of the same, but somewhat more recent, age. The Hospital Hill shales do not appear, so far as I am aware, in the Insuzi Valley.

In the Umhlatuzi Valley, separated from the Insuzi by the Empandhleni ridge, the formation is similar to that on the Insuzi, but on the Nkandhla side of the Umhlatuzi River it shows remarkable side folding. Magnetic rocks similar to the Hospital Hill shales are found a short distance higher up the river.

In the Pongola Valley, the folding is not so sharp as in Zululand, but still very decided. The goldfield has not been carefully studied, but it is known that there are at least two synclines, viz., one terminating about the farm Bellvue, with its axis towards Piet Retief, and the other with its northern limit about the junction of the Pongola and Pivan rivers. The relation of the magnetic Hospital Hill shales, which are being exploited with a view to the establishment of an iron industry, to the quartzites and schists of the series, is very plainly shown on the farms Bellvue and Paris, while between Paulpietersburg and the western limit of the series the Swaziland schists are exposed.

Important gold-bearing banket reefs have been found in the series on the Upper Insuzi and Umhlatuzi goldfields only, the banket reefs found up to the present on the Pongola field being poor. In the Insuzi the most important reefs are the Dickson, the Dickson North Reef, the Central, the Delaney and the Speedwell. The Dickson is a large pebble banket lying between schist and quartzite.

It is as a rule thin, but always rich in gold content. The other reefs are all small pebble bankets, and poorer in gold content. Though the Delaney reef is low grade, it is remarkable for the frequency with which visible gold has been found in its quartz pebbles. I do not know of such discoveries in any of the other banket reefs.

The gold-bearing quartz reefs in the series are not very important. The Wonderfontein reef, on the Pongola, is a white quartz reef containing gold associated with lead minerals. It is an interesting example of the occurrence of gold in what is known to the prospector as "hungry" quartz. In the Upper Insuzi, the "Haematite" or

"Muller's" reef lies at the junction of the quartzite and schist, the quartzite being partly replaced by the quartz. Most of the gold in the reef occurs in pockets of haematite which are frequently of cubical form, and perfect pseudomorphs after pyrites. Some of this haematite is very rich in gold.

BLACK REEF SERIES.—The Black Reef series appears at the southern end of the Nondweni goldfield, and near Denny Dalton and Ulundi. The beds are quartzites, and shales or schists, with thick banket reefs. The principal reason for considering the beds to be more recent than the Witwatersrand series is, that though they are distinctly tilted, the dip is always slight, while the Witwatersrand beds in the Colony are much folded. Unfortunately, there does not appear to be any place where the relationship of the two series can be observed directly, for both at Nondweni and Denny Dalton the Black Reef series lies directly over granite. The rocks in the supposed Black Reef series do not appear to be so much metamorphosed as in the Witwatersrand series, but that might be accounted for, apart from the difference in age, by the smaller amount of folding. The series at Denny Dalton is undoubtedly older than the Table Mountain sandstones, for the Table Mountain sandstones, at a higher level in the Entonjaneni hills near by, are only very slightly metamorphosed, and lie horizontally. Dwyka conglomerate lies directly over the Black Reef series near Nondweni, Denny Dalton and Ulundi.

The bankets appear to be coarse with little secondary silica. They are low grade except in portions of the reef in the Denny Dalton Mine.

GOLD IN TABLE MOUNTAIN SANDSTONES.—The Table Mountain sandstones are well developed in Natal on the coast side of a line running from the centre of Alfred County to Ulundi, in Zululand. In Alfred County they are white, friable sandstones, closely resembling the coal measures in appearances, but distinguished from them by the presence of overlying dwyka. Near Umzinto they become red and hard, owing to the presence of a silicious cement, becoming soft and friable again in Zululand, though still in great part red in colour. Gold is widely distributed in small quantities, but the place at which most is known of its occurrence is in Victoria County, near Chaka's Kraal and Stanger. The gold occurs in almost vertical quartz reefs, apparently following lines of faulting and subsidiary fracturing, and also in interstratified beds of conglomerate and sandstone. The gold-bearing sandstones and conglomerates, where unweathered, are pyritic, and the gold is apparently very irregularly distributed in them.

It is interesting to note that the gold occurs in the sandstone in two forms, viz., coarse, almost cubical and dark in colour, and fine and lighter yellow in colour, resembling the gold from "banket," but with some pieces of wire gold of similar colour. The coarse gold is found in weathered stone, and the fine in unweathered, and there is reason to think that the coarse gold has been formed by secondary action.

6.—SEDIMENTARY DEPOSITS IN NATAL.

By J. A. H. Armstrong.

The progress of research into the resources of Natal as a gem producing country has been extremely slow. There is reason to believe that the geological history and mineralogical wealth of our Colony is but imperfectly revealed, and thus there is still hope of success. Five years have elapsed since my attention was directed to the reported occurrence of gem-bearing alluvial beds in Northern Natal, in the vicinity of Ladysmith. During a sojourn in that neighbourhood at that time, I proceeded to the locality of the supposed find, to satisfy my curiosity and in the interest of our renowned science. The neighbouring country formations consist for the most part of various dark and light coloured shales belonging to the well-known Ecca series, similar in appearance and character to those found outcropping at various places along the Eastern Coast of Natal. These shales are frequently intruded by a dark igneous basic rock, approximating in parts to a basalt, and in parts to a fine-grained dolerite shewing the ophitic structure. These intrusions are of a complex structure, but in some cases assume the aspect of almost vertical dykes, and in almost all cases have given rise to varied and well-formed distinct hills or kopjes.

Another noticeable feature for observation is the vast number of spherical, angular, subangular, and other irregularly shaped boulders, which are to be found lying on the summits and slopes of these kopjes. The boulders consist of the same material as the intrusive dykes, and show the characteristic basaltic weathering. A curious feature is observable at times, even among the largest of these boulders, in their tending to split in pieces. This is produced by exposure to sudden changes of heat and cold. The so-called alluvial deposits are to be found in the valleys overlain by a deposit of loam of varying thickness, ranging in colour from a dark grey to a dark reddish colour, indicative of the presence of iron. The overlying deposit at places assumes a plastic nature, and thus verges on the domain of a true clay. The line of demarcation between the two series is very distinct in many places, and there can be no doubt that the alluvial beds mark a distinctly different period to the overlying deposit, and could hardly lead to the conclusion that the alluvial beds should be considered a portion of the subsoil, more especially as the underlying rocks consist of denuded shales presenting a marked unconformity, and thus totally unconnected with the series above. The pebbles constituting the greater part of the alluvial beds are of various sizes and shapes, and are often found filling up the interstices of larger boulders of a basaltic or doleritic nature that are visible. No garnets, carbons, ilmenite, olivines, corundum, or other associate-minerals of diamondiferous deposits, were observable. The pebbles consisted more or less of varieties of clear quartz, feldspar, or shale fragments, which had evidently undergone considerable wear from water action, and had almost likely travelled some distance. The whole seemed to be uniformly distri-

buted, and of a uniform character, and such beds certainly could hardly have any claim whatsoever to being ranked as gem-bearing alluvial beds. The deposits are of comparatively recent origin in the geological record, and although of no value commercially, are of interest from a scientific point of view, in that they may mark the fact of the possibility of the occurrence in South Africa of an Ice Age in Pleistocene or recent times, and thus far more recent than the one already acknowledged by geologists as occurring in Permo-Carboniferous Times, the previous presence of which was known from the recognition of such a series of strata as the Dwyka Conglomerate and other traces of former ice action. Although the South African climate may not have been so cold then as to have given rise to large icebergs and icefields, such as are to be found in many countries at the present day, yet the intensity of the cold may have been sufficiently great to have caused accumulations of ice and vast accumulations of snow on the highlands and Western Borders of Natal, fringing on the heights of the Drakensberg. Such masses of snow would, no doubt, move down into the surrounding valleys and lower regions of a more temperate nature in climate, carrying with them in the form of a ground moraine a vast quantity of detrital products: or a rise in temperature produced by climatic changes in these higher regions may have produced at times an increased liquefaction of the surrounding masses of ice and snow, and thus have given rise to torrential waters, whose violence and transporting powers may have effected the deposition and formation of such alluvial beds in the places mentioned. I do not anticipate that the degree of coldness then was similar to that found within the arctic and antarctic regions at the present day, nor that there was an equality of temperature in proceeding from the interior to the coast, but what I do venture to suggest is, that the climate in pleistocene or recent times in South Africa was considerably colder than what it is at the present time, and that there was probably a rise in temperature in proceeding from the heights of the interior to the coast line, owing to the proximity of the seas. One might be led from the occurrence of the boulders above mentioned, to suspect that they are what are known as perched blocks or erratics, and mark such a period; but they certainly appear to have had little connexion with an Ice Age in South Africa, except, of course, in so far as those are concerned which are found within the alluvial beds. The latter specimens show a different kind of outward weathering to those on the hillsides, being of an extremely light yelowish brown colour, and the effects of the decomposition extends further into the parent mass than is the case with the others. Besides, they are extremely small in average size, compared to the others, and are always found accumulated at definite spots throughout the deposits. This appearance shows that they have suffered from the effects of water for a long time, and have gathered and been puddled about. It is more than likely that those which are lying on the summits and slopes of the kopjes have at one time been portions of the upward prolongations of the dykes previously

mentioned, and that they have been broken off as the result of sub-aërial denudation, and have weathered in the spots where they are now to be found. Although no actual glacial striæ are observable, yet the underlying shales have in most places a clean-washed surface, which tends to show that the volume of water or other transporting agency must have been great in those regions. The present site of the town of Ladysmith, encircled as it is by a loop of the Klip River, denotes the site of the former bed of the river. The course of the river would appear to have travelled in those times over the entire town. In a small single horizontal bed of fluviatile deposit projecting from the present bank of the river, I discovered a palaeolithic scraper, which shows that man in those days frequented this river-bed.

In Southern Natal, however, results of research are more encouraging from a commercial point of view, and the country lying between Umzinto and the Southern Borders of Natal warrants diligent and systematic search for base and precious metals, and gems. Here the country is very rugged in parts, and here also is to be encountered the belt of primary rocks, that traverses the Colony from end to end along its central parts. Typical granites, gneisses, schists, pegmatites, and sedimentary rocks, are to be found. The granites, gneisses, and schists, seem to form the basement rocks on which the others have been laid down; but to correlate them is beyond question owing to the total absence of fossil remains and the extreme complexity of their structure. Attention, however, should be drawn to the occurrence of a particular rock in this quarter. It is of sedimentary origin, and portions of it are to be found at various spots along the Umzinto and Southern Natal Districts. It contains fragments of pure quartz, possessing an extremely high degree of transparency, fragments of felspar both triclinic and monoclinic, garnets, alivine, zincon, tourmaline, hematite, mica, cyanite, hornblende, carbons, ilmenite, and other minerals. The diamondiferous nature of this ground is beyond dispute. The soil was first discovered by me some ten months ago, on a farm in Southern Natal, and after careful microscopical and other examination, I decided on the diamondiferous nature of the deposit. Since then, on continuing further research into the matter, I have located the same soil in other distant parts, and of a better quality to that previously found. No distinct layer, bed or outcrop, can be found, so as to fix the extent, the actual site or the stratigraphical horizon of the formation, and thus research is rendered extremely difficult, but there is one thing that is certain, and that is, that the rocks are a wash of a diamond-bearing nature. My attention was drawn to the possibility of finding diamondiferous soil in Natal from the fact, that the soil of such a nature had been found in the Matatiele District, in East Griqualand, in the Cape Colony, which I found on examination, to be of good quality and a good type of 'blue-ground,' such as is usually found in diamond pipes. Other pipes, bearing diamondiferous soil, have been found in Cape Colony, Orange River Colony, and the Transvaal, and

drawing an imaginary line connecting all the sites of these pipes in the various Colonies, I formed the opinion that it would not be at all unlikely to find diamondiferous pipes within Natal, and that a line of weakness may exist in Natal, extending from the Matatiele to the Transvaal. Since then, however, I am more inclined to think that, although there is every possibility of finding a diamondiferous pipe some day within Natal, yet the greater probability is that a fissure will be found extending along such, if any, line of weakness. This view, I think, is supported by the occurrence in many Natal rivers of garnets of the precious varieties, which could not in all instances have been derived from granitic or gneissic formations or eclogite, seeing that the existence somewhere of such a formation, as I have explained, is likely, within the depths of the earth. At the spot where I encountered the stuff first, I discovered small pieces of a hard, brownish rock, of a flinty nature, which possibly may have been a kind of porcellanite derived from the baking by excessive heat of the neighbouring shales around an intrusive mass of igneous rocks. These pieces gave me an impression, that it is possible in areas where Ecca shales have been intruded by granitic rocks of comparatively recent date, that in the vicinity of the granitic bosses they have suffered so much from the intense heat and enormous pressure, that minerals may have crystallised out in the baked shales, such, for instance, as diamonds, the carbon being derived from the shales themselves. One of the small pieces found by me contained a well formed crystal of garnet, of the variety pyrope, as well as quartz crystals zircon, in the form of a perfect crystal of the tetragonal system, as well as a pure transparent diamond of the cubical form. This leads to the conclusion that diligent search for gems should be made in the Ecca shales, in those places surrounding large granitic bosses, or other large bosses of igneous rocks, are intruded.

Another series of sedimentary deposit, that is worthy of attention, is one which covers a considerable area in Southern Natal. It appears to have been formerly some kind of clayey deposit, which was full of ilmenite, olivine, and a bronze coloured mica, and which has been converted into a clay schist through pressure. The ilmenite and mica are most conspicuous, and give the strata a laminated appearance. One noticeable feature is the peculiar manner in which it is ramified in all directions by small veins or leaders of igneous rocks, and also that in places it contains at times one or more seams of quartzite of an extremely white colour. Some of the intrusive veins are typical graphic granite or pegmatite, the quartz crystals being marked by their purity and transparency, and the felspar being white orthoclase, both minerals having crystallised together, and assumed forms resembling the Hebrew characters. No gold has been observed by me in any of the leaders, but in this schist the tale is different. Near the locality where the discovery of diamondiferous deposit above mentioned was made, this clay schist is also found outcropping, and small patches in it, thought to be leaders, had been worked for gold some 25 years ago by early

settlers. Their apparently half-hearted efforts met with only partial success, and the project was abandoned, after but little practical work had been done. The fact remains that gold was found by them in rich patches in isolated spots over the extremely limited area on which work was done. It is to be regretted, however, that they were not better acquainted with the nature of the formation that they were dealing with, but such was only to be expected in the early history of a new Colony. This formation deserves diligent search and examination. It certainly appears to me to be a clay schist. Pannings made from various portions of it invariably leave a large proportion of ilmenite and black sand, and now and then a small spot of gold appears visible to the naked eye. It would appear to have been laid down among the primary formations in still water, and to have suffered during the various upheavals occurring in the early geological history of our country from the effects of pressure metamorphism. The gold found in it is either flowery or in small nuggets of extreme purity. It is in these primary formations, I believe, that the true origin of Natal gold will be found. Pannings from the surface soil (which is of a dark colour where this particular rock outcrops), almost always show a trace of gold, which, no doubt, has been derived from this series of rock.

7—NOTES ON PETROLEUM INDICATIONS AROUND HARRISMITH.

By Rev. J. Fitz-Henry.

The "Platberg" mountain, near Harrismith, 8,000 feet above sea level, and capped with volcanic rock, common to the highest points of the Drakensberg range, affords an easy geological landmark in helping us to note the geological horizon of the petroleum indications in the Eastern part of the O.R.C.

Under the "volcanic capping" lies clearly marked the "cave sandstone" of the Stormberg series, some 300′ thick. From this sandstone to the bed of the Wilge River, the lowest part of the land surface at the base of the Platberg, lies a series of alternating sandstones and shales, the "Red beds" of the "Stormberg." In these shales, at a point 5,700′ above sea level, and 500′ over the Wilge, occurs the first petroleum indication found during bore operations for water.

The second point is on the water edge of the Wilge, some four miles distant, in soft, grey sandstone, underlying a bed of shale. Further down the river, nearly at same level, at a point where a dolerite dyke crosses the river, the third indication is found. Not now in shale or sandstone, but in crevices and cleavage lines of the dolerite, where it touches the local country rock. Whether the petroluem found here came from below, as water often does along the side of the dyke, or from the adjoining shales, we cannot tell without further boring and investigation.

Comparing the occurrence of petroleum at Harrismith high up in the "red beds," and in layers 500 feet apart, with its occurrence at Matatiele, in the "Coal Measures," noted by Mr. Schwarz (*Geolog. Survey Report*), as well as on Bloemfontein commonage in the lower Karroo (Ecca shales), we may infer that petroleum occurs not only in one geological formation, but in three, possibly four formations of the Stormberg and Karroo series. And we may also infer the wide extent of country over which the indications occur, looking at the distance from Vrede and Reitz to Bloemfontein, from Ficksburg across to the outcrop of the coal measures in Matatiele, over the Drakensberg.

From the very meagre indications in all these places on the surface, we can offer no opinion on the possible quantity of petroleum which further work by companies interested may reveal.

In the discussion, Mr. C. J. Gray said: "I would draw attention to the bituminous shales associated with the Stormberg coal seam, in the Drakensberg in Natal, referred to in my paper read yesterday. Those shales, near the headwaters of the Umkomaas River, have repeatedly been "taken up" with a view to distilling oil from them. They yield about 20 gallons of crude oil per ton. Though the important occurrences of free oil, in America and Russia, are not connected with oil shales, it appears that there may be some connection between the occurrence of small quantities of oil in the Cave sandstones near Harrismith, and beds of bituminous

shale in the underlying Stormberg series. The intrusion of igneous rocks through such shale beds might cause partial distillation of oil. The idea receives some support from the occurrence of oil in the joints of a dyke, mentioned by Mr. Fitz-Henry. On the other hand, the discovery of oil in the Kimberley or Ecca shales, near Bloemfontein, if such a discovery is an undoubted fact, cannot be explained by the presence of oil shales in the more recent Stormberg beds."

8—COMPLEX ORES.

By Duncan Simpson, F.C.S.

[Abstract.]

Deals with composition and varieties of complex ores carrying noble and base metals. Gives geographical distribution of some of the best known ores. Discusses methods adopted in various districts for the treatment of such ores, and the recovery of the contained metals.

Relates experiments recently made by the author in "heap roasting" a copper ore containing silver, nickel, lead, and zinc, at places in Natal and Zululand.

9—SOLIFLUCTION.

By Prof. E. H. L. Schwarz, A.R.C.S., F.G.S.,

[Abstract.]

Prof. J. G. Andersson, of Upsala, in a recent paper, (1) proposed to call the movement of rock waste saturated with moisture, down the slopes of hills, "solifluction," from *solum*, soil, and *fluere*, to flow. Andersson took most of his examples of this movement from high latitudes, and from lofty mountains, where the disintegration of rocks is rapid, and the amount of water, resulting from the thawing of the covering of snow and ice, was very great. Thus the stone rivers of the Falkland Islands are explained on this assumption of flowing soils, and similar occurrences are noted in Spitzbergen, Scandinavia, Tibet, the Urals, etc. Prof. W. M. Davis had already noticed the slow movement of the waste-sheet down slopes in temperate climates, (2) and Andersson's term is now generally applied to this movement, whether rapid or slow, according to the climatic conditions of the locality.

In South Africa, both the rapid and slow varieties of solifluction occur. Of the former, an excellent example occurred at Clifton, near Sea Point, Cape Peninsula, which was fully described in the 10th Annual Report of the Geological Commission; (3) here the soil was scorched by a bush fire, and the loose grains absorbed moisture till a quicksand was formed on the surface, which gathered into a stream that tore down the hill-side, carrying huge boulders along with it. It is to be noted, that the specific gravity of the viscous mud or quick-sand is very little less than that of the boulders which it carries along with it, hence its ability to move huge blocks, which practically float in it.

Mr. Schlinnberger, in a similar mud-rush in the Alps, estimated that the amount of water entangled in the sand was in the proportion of one to three. (4)

Along the faces of the steep hill-sides in the Karroo, and in the coastal ranges of the South West of Cape Colony, there are often seen lanes of bare stones, usually bordered by green strips of luxuriant bush. These have formed in the same way through transport by solifluction. On examining the fresh falls, the stones are seen imbedded in sand, but subsequently the sand is washed from between the blocks on the surface, and a stone river is exposed.

A more general example of solifluction occurs in hills like those round Grahamstown. On the north of the town there are steep slopes, capped with hardened gravels, belonging to an ancient peneplain. The latter occurs almost like a horizontal covering of lava,

(1) Solifluction, a component of subaerial denundation; Journal of Geology Chicago, 1906, p. 91.

(2) W. M. Davis, Physical Geography, p.p. 263, 267.

(3) The term "solifluction" was applied to this independently by S. Passurge, Petermann's Geogr., Mitteilungen, 1907, xii. p. 229.

(4) P. Demontzey, Reboisement des Montagnes, Paris, 1889, Note A.

and the edge is continually crumbling away as the slopes composed of soft clay disintegrate, thus giving rise at first to blocks of ferruginous surface quartzite, which subsequently break down into smaller fragments. The fragments work down into the subsoil, and rest as a layer of gravel upon the sloping surface of the clay.

During periods of drought, the whole surface becomes dried, and, when the October rains set in, a large amount of moisture is absorbed, which renders the clay greasy. Every year, then, the covering of gravel sub-soil slides a little down hill, and the effect is that of a glacier-borne ground moraine; in road cuttings along the hill sides, this sheet of gravel can be seen riding over obstacles, covering up earlier river-channels, and thinning out in the elevations of the contours of the ground. There is evidence in this, that when the valley in which Grahamstown stands was first cut in the peneplain, there was a greater rainfall, and the river channels were kept open; now the surface of the hill-sides, on the north of the town, at any rate, have been covered up by this sheet of slowly moving gravel, and the surface of the ground does not show the presence of the earlier river-courses.

In England, the same solifluction occurs in the chalk districts. At Lingheath and Brandon, in Suffolk, the sand and gravel lying on the chalk, occurs as a very wide-spread deposit, containing palaeolithic implements; it covers almost the whole face of the country reaching the highest ground, and plunging into the valleys quite irrespective of the present drainage system. (5)

(5) S. B. J. Skertchly, Mem. Sect. Survey, England & Wales, Manufacture of Sun-prints, London, 1879, p. 6.

10—IRRIGATION IN THE ORANGE RIVER COLONY.

By C. Hassard, M.I.C.E.

11—LACK OF WATER IN NATAL.

By C. F. Freeman-Lake.

12—RECONSTRUCTION AFTER THE BOER WAR.

By W. H. Sharpe, B.Sc., A.M.I.C.E.

13—RAILWAY EXTENSION BEYOND THE VICTORIA FALLS.

By S. F. Townsend.

First extension Zambesi Falls to Kalomo, 96 miles, commenced September 1904; Kalomo reached May 1905. Further extension to Broken Hill, 281 miles; commenced June, 1905, completed August 26th, 1906. Permanent way, 60lb. rails, steel trough sleepers. Maximum grade 1—80. Curves of 10 chain. Contract Kalomo—Broken Hill specified one mile track-laying per day; best day 5¾ miles track laid; last mile to Broken Hill was laid in half an hour; a kinematogram was taken of this bit of work.

Three miles beyond Falls crossed the Maramba River: bridge 100 feet span. Kalomo River has a bridge with three spans of 100 feet each. Between Kalomo and Broken Hill nine rivers crossed, Kafue the largest, has 13 spans of 100 feet each.

Contractors' main depôt was established at Livingstone, five miles north of the Falls.

14—ELECTRICITY IN MUNICIPAL WORKS.

By J. Roberts, A.M.I.C.E.

15—EDUCATION OF THE PUBLIC IN ARCHITECTURE.

By R. G. Kirkby, A.R.I.B.A., M.R.S.I.

16—THE CRADLE-LANDS OF ARCHITECTURE.

By W. Lucas, F.R.V.I.A.

17—CHURCH DESIGN.

By E. O. Payne, A.R.I.B.A.

18—DOMESTIC ARCHITECTURE.

With Special Relation to the Requirements of Natal.

By C. W. Methven.

A consideration of the natural growth of the noblest forms, from the most simple and primitive, leads me to touch upon the problem, which faces us all here as pioneers in the development of Architecture in a new country, without an ancient history or civilisation of its own, so far as we are aware, and in a moment, so to speak, lifted out of the position of an unknown and savage continent, into a land peopled by the most civilised nations in the world, and undergoing a process of development by the latest resources of modern science and invention.

There is, therefore, in this country no gradual evolution of later and more civilised forms of architecture, from older and more primitive forms as in other countries. The primitive forms are still with us to-day, and we have simply come upon them suddenly and without warning, and have begun to erect side by side with them, in the case of public, commercial, and domestic buildings, the selfsame structures, that adorn, or disfigure, the cities of London and Birmingham, and their suburban districts. To use the expression of the poet, Wyville Home, "Cancerous cities, which eat the greenness up of wood and sward," are growing apace in South Africa, with all their attendant districts allotted for residential as well as commercial purposes, and the question is, are we doing what we can, to make our homes such as they should be, in the midst of their natural surroundings, and under the geographical, geological, and climatic conditions of the country.

We appear in this Colony of Natal to have nothing to perpetuate in our Domestic Architecture akin to the picturesque old Dutch house, such as we see in the Cape Colony. Whether, owing to the curly outlines of its gables, its steep pitched roofs, often thatched, the prominent ornamental chimney stacks, the broad stoeps with their heavy columns, bold panelling, and grotesque carving, with white the prevailing tone, making a most picturesque whole; or whether it be partly also due to association; these old Dutch houses certainly have a peculiar charm all their own, and appear to exactly suit both the climate in the southern parts of Cape Colony, and the romantic scenery which in many cases surrounds them.

With their thick walls, and thatched roofs, cool in summer, and warm in winter, these Dutch homes seem exactly to suit the variable climate of the Cape, and to accord with their botancial surroundings, which are of a less tropical character than ours.

We have no such precedent to follow in this Colony, I am sorry to say, and I do not think this style could be so appropriately introduced as in the Cape Colony. The Dutch settler was not here early enough, or long enough, to leave us any picturesque legacies of this kind. We have had rather a clear field, but what have we done?

Planted it over with not even the latest or best examples of cockney villas, with little regard to climate and therefore with not much to comfort; with no regard to that beauty which can only be gained by fitness to environment including available materials, and without anything like full use of those which abound in the country because of the difficulty of obtaining them at a rate which renders their use practicable.

Perhaps, this description is somewhat overdrawn in many cases, especially where, I think, as in late years, a great advance in good taste has been evident in the design of many of our homes. I do not for a moment except myself from the long roll of sinners in some of the above respects. There are overwhelming difficulties in the way of carrying out what one would frequently wish in connexion with the design of villa and other residences—difficulties of cost—difficulties of skilled labour and craftmanship, and also too often the insuperable difficulty of dictation on the part of the owner as to the arrangement of the accommodation he wishes. Though, as a rule, the architect will meet them willingly in trying to provide these arrangements, yet, if owners would only realise how much to their advantage it would be to let the architect, out of the fulness of his experience, suggest the most suitable arrangements for providing the required accommodation, one great difficulty in the way of obtaining comfortable and picturesque homes would be removed, and the owner would have ideas presented to him which had perhaps never occurred to him on account of the necessarily limited nature of his experience and because his mind has been captivated, perhaps, by some particular plan he has seen to the exclusion of all the others he has not seen.

The fact is, we have, in this colony at least, only one early tradition upon which to build, as regards our architecture, and that is corrugated iron—to which in more recent years has been added Portland cement. The fatal facilities afforded by the two materials I have just named, has done more than at first sight appears towards the degradation of our domestic architecture. Had we been thrown more upon our own resources in providing the materials with which to build—the materials placed by nature in many localities to our hand—what a vastly different development in our dwellings would have taken place !

It is well known that in the older countries, the style and methods of house and cottage building vary in accordance with the underlying geological formation, and the abundance or otherwise of certain kinds of timber. The whole design of a house will frequently be affected by this. The thatched roof must be steep to throw off the rain rapidly. Roofs covered with slate or slabs of stone may be of low pitch, and if with tiles of intermediate pitch and angle tiles which are readily moulded, hipped roofs will be suggested.

Again, timber-framed houses will have overhanging gables. Windows will vary according to the available stone in the neighbourhood being suitable or not for mullions and sills and lintels—

or they may have wood frames only. The walls may be of shale, or dressed sandstone, or random rubble, or of brick, if there be suitable clay. There are, of course, a hundred other variations, which may have to be dealt with, but the right treatment of available materials, and a proper consideration of what is sometimes called "surface texture," will infalliably result in good domestic work, which will harmonise with its surroundings. Where skilled craftmanship is not available, and materials are of the simplest, then the architect may safely take refuge in simplicity of design, and so long as the construction is sound and sincere, and the planning good, there need be little fear of the resulting architecture.

Some of the most picturesque, homelike and lovable abodes I have seen in this country, have been more or less ramshackle, saggy-ridged, tile-roofed, and shale-walled farm houses, nestled away among the hoary, lichen-covered, yellow-wood trees of the up-country forests, and built by the farmers themselves.

I think I will carry you with me, if I say that it is not the plan prepared merely, or mainly, because of some hankering after a fanciful and prettily designed villa, seen on some sketching tour at home or abroad, and which is to be incontinently stuck up on the site, but rather the impressions and inspirations of the site itself and its environment, which should guide us both as to plans, elevations, and garden—for I hold strongly that the laying out of the garden, at all events as regards its main features, should form a part of the architect's work. This is the more important as regards the portion in immediate proximity to the house, and as regards the approaches. I cannot lose this opportunity of deprecating the extraordinary infatuation which seems to possess so many of those, who become the owners of natural bush-covered sites, on the coast especially, in thinking that the preliminary step to building their home, is necessarily to "clear the site," as it is termed—and with a vandalism almost surpassing belief, denude the ground of every bit of its natural adornment. This for the purpose of "opening up the view," as it is called, quite oblivious of the value to the view of its foreground. The effect of a view may be sometimes quite spoiled by the removal of a solitary tree, which happens to be well placed in the foreground.

Cape Town and Durban are happy in having a profusion of exceptionally beautiful sites, some of them commanding extensive prospects, either seawards or inland, and nearly all of them possessing special adaptability and suggestiveness for dwellings, which, whether luxurious and palatial, or modest and simple, can always be made homelike.

As regards the proper aspect for houses in this country, we are not, I think, so restricted as in England. In Scotland, for instance, we have to nurse every bit of sunlight we can get, and, in consequence, wherever possible, the approach should be from the North and the public rooms should face South and West. But here we have rather to guard against too much sun and heat, and with the assistance in these respects, which we are able to obtain by the use

of the verandah, we can, with due respect to the power of the afternoon sun, place our houses pretty well as we like, depending, of course, on the site and its prospect. Indeed, I think, one of the best arguments we have in favour of this view, is that the conditions of light and heat in this part of the world have not naturally and of themselves dictated any sort of rule or custom in this respect. On the contrary, we see all over our residential suburbs, that the dwellings face, or have their public rooms facing every point of the compass, the main influence being prospect or view.

There are, of course, some points which have to be considered in this case, and one of them is that under our conditions of climate, one of the most frequently used portions of the house is the verandah, and it is advisable, especially if this exist on one side only, as it often does, that it should not face the rainy or windy quarter. This, however, is often difficult to arrange, as frequently a dwelling may have to face that quarter for the sake of the outlook, and the proprietor may not be able or willing to afford a second, or side verandah. If, however, it be possible to approach the house from a different direction from that of the main prospect, there is no reason why the public rooms and the solitary verandah should be in what is commonly called the front of the house, and face the road or approach, or why they should not face any direction the proprietor may wish. We are apt to lavish all the so-called decorative work we can afford, upon what is usually termed the front of our dwellings, and to let the back take care of itself. But if there be a garden of even reasonable dimensions at the back, a frequent resort of the owner, what then ? Surely this side of the house is peculiarly his own, and whatever he may give to the public on the street side, surely the side which is entirely his own should have its special attractions, and be a pleasure to look upon, enhancing those of the garden. If you are in the garden, the house becomes your middle distance. If, on the other hand, you are within the house, in its porch, or on its verandah, the latter becomes your foreground, when looking at the garden, and should be treated accordingly. I often think, that in small cottages, especially where in nine cases out of ten, the owner never thinks of any other course than to present his most elaborate front and his one verandah to the public, that side might be devoted merely to the necessities of public entrance, and the principal rooms and the verandah made to face sideways, if the prospect is there, or to the back, if there be no prospect, but a garden. Why should the garden be invariably given to the public, and a back yard only to the owner ?

The question of the adaptation of the building to its home environment and the surrounding landscape, is by itself a very large subject to traverse, and one as to which we have not in this country many examples of an inspiring nature. In general, the various districts of a country have their own special types of architecture, the outcome of their special conditions, and suitable, with the requisite modifications, to both rich and poor. The frowning

castle crowning the sudden rocky eminence, breaking upwards out of the midst of quiet undulating valleys, only enhances by its bold contrast the pastoral beauties of the lowlier dwellings at its foot. It is only needful that it fills its appointed place, and by its very antagonism harmonises with its surroundings. But it is a hard question to answer, what style or general type of building of this class is most suitable to our climatic environment. Probably the best way to get at this is to assemble together some of the main conditions under which we live, and to consider what, following thereon, we are likely to want, and what to avoid.

I shall, therefore, consider the conditions in Durban only as an example. The geographical position is one on the seaboard, and within the semitropical belt. The climate, we all know, is often steamy and hot in the summer months, and particularly so during the nights. During the winter months the temperature seldom falls much below 60 deg., and is often higher, but generally the climate for these months is equable and delightful, cool by comparison to the summer months, but hardly ever cold enough to make fires tolerable in any of the rooms, and the annual rainfall is small. The summer heats are sometimes tempered by comparatively cool sea breezes. We are subject to heavy torrential rains and violent thunder-storms, often accompanied by severe hurricanes of short duration, but quite long enough to do severe damage. The soil is for the most part sandy and porous, except in some of the low-lying districts, but it is generally reproductive. There is a plentiful water supply and a good drainage system in Durban, but neither outside the Borough limits. European servants are employed as a rule only by the well-to-do, and Kaffir and Indian servants are the rule.

The suggestions which seem to me to be offered by these conditions, are the saving of as much labour as possible, a condition admirably fulfilled by the bungalow style of residence; that stairs are objectionable, as increasing the labour of those who order the house, and that, therefore, the one storey house is preferable for that reason to two or three storey buildings, which in colder climates are the rule. Provision is required for a plentiful supply of fresh air, and particularly for the inlet of any cool breeze arising during the warm nights. At the same time, it is undesirable to sleep with unsecured open doors and windows, thus leaving the house available to prowlers by night, a requirement which may be met by double sashes or casements, lined with wire-gauze, to exclude mosquitoes and other flying pests, or by louvred casements. Even on these, wire-gauze is an advantage and does not show when they are opened during the day. I have even seen a verandah so protected by wire-gauze that it could be used as a sleeping apartment on warm nights when desired, and there is no reason why in some houses special arrangements should not be made to provide sleeping compartments of this nature.

Sustained periods of drought, causing much dust, entail a good deal of labour in window cleaning, and this is enormously increased

by small panes of glass. Small panes are also irritating, when there is a good view; plate glass is then indefinitely preferable in moderate sized panes, and costs little more than the small panes of sheet glass with the greatly increased wood or metal work in connection with same.

Roof coverings should be non-conductors of heat, and corrugated iron ought never to be used. It is equivalent to living under a stove. The same material should never be used for wall linings, unless protected all round by verandahs of ample width, and if insisted on for roofs, should have some interior lining with, if possible, an air space between the iron and the air contained by the interior of the roof, which should be abundantly ventilated besides. Walls should be thick, instead of being invariably cut down to the minimum requirements of the municipal authorities, and special means should be adopted when absorbent bricks are used to render them water tight on the sides exposed to the heaviest rains and gales. Under these conditions either stone or hard burnt bricks would be the most suitable materials, and it is somewhat surprising that rubble-built walls are not commoner than they are.

A cool appearance should be aimed at, which, by reason of its usually being attained by the use of stucco, rough cast, or even white wash, results in actual coolness by reflexion. Window openings, where not exposed to the sun, should be large, and the reverse where so exposed, and bays should have French casements, or, at least, casement sashes, and doors. Indeed, wherever possible, in all rooms, the arrangements should be such as to enable the whole house to be opened up to every breeze that blows.

Fireplaces, outside of kitchen requirements, are not needed on the coast of Natal, except for emergencies in one or two rooms at most, and then, if possible, they should be made ornamental, and on the open hearth principle, so as to be available as receptacles for ferns or plants, for which they will be used practically the whole year round.

Special provision is required to provide for the running off the heavy torrential rains. In flat-roofed houses gutters of any size can be constructed and kept out of sight, but eaves gutters must either be of a size which looks ungainly, or else a large number of down spouts must be provided, which are always more or less clumsy in appearance.

Owing to the plentiful water supply in Durban, the bath may always be looked upon as one of the necessities of the climate which is within the reach of everyone, and the bathroom in all homes should be made a greater feature of as regards its comforts and appointments than it is. And not to enlarge on these details too long, lastly, the house must be absolutely proof against our greatest insect pest, the white ant, which is quite a practicable end to achieve, if it is gone about the right way from the beginning.

Generally and broadly speaking, the two great classes of style upon which we may draw for our inspirations, may be said to be

Classic and Gothic. The Classic division has been taken by a writer on this subject as including Italian, Greek, and what is known as Queen Anne or Free Classic—and Gothic, on the other hand, may be taken as including the pointed styles, such as early English, Decorated, Perpendicular, Tudor, Elizabethan and Jacobean. Nearly everything we build, may be inclined as being at least allied to one or other of these styles.

I am disposed personally to think that while the pointed styles, and Elizabethan, as above referred to, are eminently suited to the homes of England, the Italian-renaissance would be found to be more adapted to our climatic and other conditions, where villas of any pretensions are erected, and it is surprising, I think, that so little attempt has been made to introduce either this style or the simpler forms of Venetian Gothic work. These styles, coupled with the system of the ancient Greeks and Romans of grouping the various parts of the building round a central court or peristyle, georgeous in colour as it may easily be made in this climate with a profusion of flowers, need not involve extraordinary expense or costliness of detail.

Extremely effective work could be carried out in most cases with such simple materials as brick work and cement, or terra cotta. But with regard to the former material, brick, I take this opportunity of asking whether much more might not be done by brickmakers, in placing within our reach for such purposes a greater variety of moulded bricks, and a greater variety of colour. The brickmakers of to-day, as a rule, aim at producing bricks as exact in shape, as sharp in the arisses, as smooth as possible on the surface, and of as uniform and bright a red as they can make them, and it is a very common practice to select carefully the face bricks so as to reject any which vary in colour, thus producing in the wall filling as monotonous an appearance as is practicable. Then, by way of improving matters, the detestable method is perhaps adopted of covering the mortar joints with a pointing of thin strips of white lime putty, or perhaps black charcoal lines, having, of course, first roughed the brickwork all over with venetian red, joints and all, so as to complete the final likeness to the white jointed doll's-house of our infancy, a triumph of soulless uniformity, delightful to the heart of the modern bricklayer.

The treatment of moulded brick work was carried to great perfection in Northern Italy, during the Gothic and early Renaissance Period, and there is hardly any beauty of detail or design on a small scale, which may not be obtained by the use of well burned moulded bricks of variegated colour. And where stone cannot be obtained, except at prohibitive prices, for the work in question, projecting cornices, etc., can always be reliably overcome by the use of Portland cement, provided proper precautions are adopted as regards its quality and its use—precautions which, I fear, are not always as rigidly enforced in ordinary building work, as they should be. There is, probably, no greater source of evil in the production

of the numerous fine cracks, which deface the cement work of many of our buildings, than the neglect of the simple precaution of thoroughly air slaking the cement before use. I have referred to the ancient Greek style of domestic architecture, with its porch leading into the atrium, and thence to the peristyle or more private part of the dwelling. There appear, however, to be but few traces left of it. It is said to have practically perished. In Pompeii, I had lately the pleasure of examining some of the old Greco-Roman houses, and could not help being struck with the delightful repose of the inner court referred to, and its suitability to a climate like ours; privacy, coolness and shade being so happily combined. The forms of Greek domestic architecture are, of course, of a character widely differing from their religious type, and that they may be adapted with success to our own purposes was very happily proved in a work by the late Mr. Thomson, of Glasgow, unfortunately not now obtainable, which contained some admirable and highly artistic adaptations of this style for domestic purposes. That it did not meet with great public favour in a climate like that of Scotland is not much to be wondered at, but that it would be found very suitable and charming in effect in this climate, I am convinced. On the Italian villa, I might enlarge. Pugin says: "I will maintain and prove that climate has always had a larger share in the formation of domestic architecture, and the Italian is a good illustration of the truth of this remark. The apertures are small, long colonnades for shade, the whole calculated for retreat and protection from heat; the roofs are flat in pitch, from the absence of heavy snow, and plan and outline are both suited to the climate to which the architecture belongs."

I now close this paper, in which, instead of dealing with mere technical details of construction, I have endeavoured to lay before you a few thoughts on the broader aspects of the subject of building our colonial homes. I have done this with a due sense of humility in approaching a subject of so far-reaching an influence as regards colonial life and character, and one so full of difficulty and so open to quite legitimate differences of opinion, and I can only hope that the views I have expressed may be of some interest to you and instrumental in giving some indication to the building public of certain lines of thought, which it would be well to follow, previous to the erection of so all-important a building as a home for themselves and their children.

SECTION D.

Botany, Zoology, Agriculture & Forestry; Bacteriology, Physiology, Hygiene.

Section D.

PRESIDENTIAL ADDRESS:

By Lt.-Col. H. Watkins-Pitchford, F.R.C.V.S., F.R.S.E.

Our section comprises a field so broad, and embraces such widely-sundered lines of scientific thought, that it is obvious that one individual—though he may have the hardihood to preside over such a Section—cannot pretend to more than a superficial knowledge of the majority of subjects included therein.

I shall, therefore, confine my remarks to one small corner of my own special subject—Bacteriology—knowing that even by so narrowing down my horizon, I shall frequently be confronted with the unexplored and unknown, and at best be able to throw but a feeble ray of light upon a subject, in which all South Africans must be more or less interested.

The Horse, with its congener the Mule or Ass, has been bound up with the progress of Man from remote times, and, a moment's reflection will suffice to show that he is still indispensable to us in our pursuance of the arts of Peace or in the successful waging of War.

The welfare of the horse, and the suppression of a horse-disease, which has almost extinguished the species in vast tracts of our Continent towards the Equator, constitutes a question to which none of us can feel indifferent; involving as it does a problem nearly related to the prosperity, both economical and social, of the land in which we live. We know from the records of the Cape Colony, that this equine scourge troubled the early settlers of 1709, as much as it does the South African of 1907. It will suffice to mention the theories held in early times concerning the causation of the disease, namely: cold, dew, miasma, cobweb, the precipitation of pathogenic spores from high altitudes, the gummy exudate from our indigenous thorn or mimosa trees, mists, and winds from certain points of the compass, and many other ideas. It is, of course, easy to argue from the cause to the effect when the former has been established, but it always struck me as strange that amid so many theories and speculations, the parallel of the Malarial disease of Man had escaped application to horse-sickness. Both are essentially paludal or marshy diseases, and the conditions favourable to the spread of one, must always have been concerned in the manifestations of the other disease.

Shortly after coming to this country, in 1896, I suggested in some of my earlier observations the parallel between malaria and horse-sickness, and attempted to apply the comparison to the solution of the question of the cause of the latter disease.

An irreconcilable difference, however, appeared to exist in the presence microscopically in one disease (malaria), of a large and easily demonstrable organism, which rendered the parallel between the diseases a difficult one to accept. The similarity in some points between horse-sickness and the human disease, yellow-fever, did not at the same time escape notice, for, while the paludal influence was existent in both diseases, an ultra-microscopic cause was *common to both horse-sickness and yellow-fever, i.e.*, the *materies morbi* was invisible to the most careful microscopic scrutiny, but was, in both diseases, capable of passing through the pores of a porcelain filter fine enough to arrest the passage of all known microbes.

In view of certain parallels in the incidence and morbid anatomy of malaria and the yellow-fever of man, I hazarded the suggestion that the causal factor of horse-sickness was a flying insect (probably a mosquito), and this opinion received strong support from the subsequent discovery that yellow-fever also was due to the attack of a mosquito (the *Stegomyia fasciata*), and that horse-sickness (as an insect-borne disease, with an ultra-microscopical organism), thus found a further parallel in the yellow-fever of man.

It was not, however until 1901 that I was able to put this theory to the test, for the visitation of rinderpest and the late war prevented the carrying out of any adequate lines of experimental work. Field experiments, however, conducted in 1891, resulted in my being able to demonstrate the agency of a flying insect in the production of the disease, and in being able to suggest a practical method of preventing the same; by keeping stables, horse-lines, etc., and their immediate environs, enveloped from sunset to sunrise in a haze of smoke, generated by smouldering fires of damp hay, stable litter, etc. Where such measures have been adopted, the best results have been secured, but where the precaution has been taken in a half-hearted and perfunctory manner, or where it has been necessary to use horses after sundown, or even leave them standing still during sultry days in dangerous localities, the disease has manifested itself, even though such animal might have been stabled at night in a smoky atmosphere.

The actual species of mosquito or blood-sucking fly, concerned in the production of the disease, is still a matter for future research, but the decision of this point cannot, I think, have any very great weight in regard to the question of the *prevention* of the disease, which is the all-important question from the point of view of the horse-owner, as well as of the practical investigator.

The problem of protection, or the production of an immunity, to this disease, has long exercised the minds of scientific workers in South Africa, particularly during the last decade. Efforts towards this end have been made also by scientists even in London, Paris, and elsewhere, but though such men as Koch, Bruce, Danysz, and Bordet, of the Pasteur Institute, Theiler, of the Transvaal, and Edington, of the Cape, have brought their experience to bear on the problem, no adequate means of immunising, and so preventing the horse contracting the disease, have been devised.

Edington, of the Cape, who worked long and laboriously at the problem, was the first to shew, in 1900, the possibility of producing by hyper-immunisation a serum, which would to some extent arrest or modify the course of the disease. Professor Koch, later in 1904, followed on much the same lines, but did not materially advance our prospects of a practical method of inoculation. Dr. Theiler, however, pursuing the same system of serum-therapy, has been able lately to devise a method whereby the mule can be rendered practically immune to the attacks of the disease, and to this worker, who has done so much for science in other branches of preventive medicine, we must accord the honour of first practically applying a system of prevention which, though still on approbation as regards the length of immunity conferred, bids fair to solve the difficulty of keeping the mule alive in districts where it previously ran much danger of succumbing to the disease. The system employed, as you are probably aware, is in brief and simple language somewhat as follows :—

A mule, *recovered* from the disease, is subjected to repeated and increased injections of blood taken from other mules *suffering* from the disease. In time, its blood becomes strongly antidotal, and when this blood, or the serum of the blood, is injected into healthy mules, together with a small dose of virulent blood, taken from a mule suffering from the disease, a mild form of the malady follows, which protects against a natural (and probably fatal) attack of the disease. The quantity of this antidotal serum necessary to immunise one animal, is 300 cc., which is equivalent to about a pint of the original blood of the immune mule, which mule would upon this computation furnish sufficient serum to immunise 8 to 10 other animals at one abstraction of blood.

The degree of susceptibility of the mule, however, to the disease is considerably less than of the horse, and a system which can with safety be applied in the case of the mule fails when the attempt is made to apply it in the case of the horse. The marked susceptibility of the horse to the disease does not constitute, however, so great a difficulty to the scientific worker as the fact that the degree of susceptibility between *different horses* is extremely variable, so that preventive measures adjusted safely to one animal, prove dangerous to others. This is the main difficulty which has confronted successive investigators, and checked the devising of a practical system of preventive inoculation.

In following a case of infection by horse-sickness in the horse, we find that where a fatal issue is about to ensue, certain of the white cells of the circulating blood become greatly reduced in their numbers; and conversely, when an animal has become infected and has successfully resisted the disease, these particular white cells—the *polymorphonuclear leucocytes*—become largely increased in numbers. Successful resistance, therefore, to the disease-attack increases the number of these particular cells, and defeat and approaching death can be foretold by their diminution and disappearance.

Knowing the functions and behaviour of these cells in diseases other than horse-sickness, we are justified from the above facts in attributing to this class of white cell an essential part in the defence of the system against horse-sickness. The highly resistent or hyper-immune horse, which can tolerate enormous doses of infectious blood, does not, however, shew any permanent increase in the number of these cells, and further, the blood of such a horse could be abstracted and replaced by the blood of a normal horse—all of these cells being thereby theoretically removed—and still the animal would retain its immunity or resistive power to the disease. The defensive mechanism, therefore, of the immuned horse cannot be entirely in the white cells circulating in the blood.

Through the researches of Metchnikoff, however, we know of the existence of other cells, the so-called "fixed cells," which, while immobile and attached to the various organs and tissues in which they are found, are nevertheless able to exert a defensive action similar to that of the free or wandering white cells. When once these cells—free and fixed—have become trained to take the offensive against the microbe of horse-sickness (Metchnikoff speaks of the "education" of the cell), the animal successfully resists infection, and so becomes immune. When thus immunised, successive reinfection, either natural or artificial, strengthens the defensive mechanism, and increases the degree of immunity, to such an extent that we are able, if we wish, to abstract the animal's blood, and utilise this defensive and protective principle in the form of the so-called immune serum.

As far as we know, there is only one way in which the horse can become actively immune, and that is by fighting and overcoming the microbe of the disease. Natural recoveries from Horse-sickness, however, are not at all so rare an occurrence as we have in the past supposed. When the disease has progressed as far as the stage of effusion into the lung and heart sacs, recovery is, indeed, a forlorn hope, but I am convinced that thousands of horses are annually infected with horse-sickness, and recover from the same, without raising the suspicion in their owner's minds of the existence of the disease. In fact, the horse is quite able to "put up a fight," as the saying is, against horse-sickness, and often to win the battle through the instrumentality of that best of physicians, the *vis medicatrix naturae*. Where, however, the infected animal is handicapped by debility, bad management, hard work, or excessive exercise, the disease becomes established in its familiar and recognised phases, and when matters have gone thus far, vain is the help of man.

If natural attacks and recoveries are frequent, it would seem that no great difficulty should be met in securing recovery from experimental infections. Such, however, is not found to be the case in the horse with his very varying degrees of susceptibility, and hitherto the introduction of even minute doses of *virus*, if sufficient to evoke a reaction at all, have been attended by the gravest risk of the disease "getting out of hand," so to speak, and imperilling the

animal's life, even where large quantities of immune serum are given in the hope of holding the infective process in check.

Where then is the best point for attack in this problem of the protection of the horse ?

My impression—formed from following closely the work of Edington and Koch, as well as from my own laboratory experiments —is, that serum therapy will not assist us greatly. Serum is uncertain in its effect, often over-restraining by a passive immunity when we seek to produce a reaction, and as often failing to exert a sufficiently restraining influence and so permitting a dangerous reaction to ensue. We cannot standardise it, and so adjust the exact dosage, because the *virus* of horse-sickness varies greatly in its virulence from one locality to another, and there is further the difficulty that the horse (which is practically the only animal suitable) differs greatly in his degrees of susceptibility, so that a given dose of our uniform *virus* would produce in one case a mild attack but cause death in another. This prevents our estimating or prearranging— except in the most general way—the restraining or protective influence of such serum in any given case of infection. I dare not attempt to dogmatise or to put forward my views on this point as final, but I am not sanguine that the application of serum-therapy to the immunisation of horses against horse-sickness will be attended with any very practical or satisfactory results.

The point of attack, therefore, has for some time past seemed to me to lie rather in the direction of attempting the *modification of the actual* virus *itself*, and by reducing it to its lowest degree of virulency, without impairing its activity, to render it safe for the inoculation of even the most susceptible horse. As the more susceptible among horses will naturally be the first to fall victim to the conditions of natural infection, I am sanguine that it will be proved that the establishment of an immunity sufficient to tide over this degree of susceptibility, will be sufficient to meet the practical needs of the question. In other words, if we can protect our most susceptible horses, the less susceptible can be left to look after themselves.

Such an attenuated virus would be looked upon as a vaccine, and it is by the use of such a vaccine, that I hope this very knotty problem in preventive medicine will be solved. Speaking again with reservation, I feel sanguine that the production of such an attenuated virus—a vaccine in fact—*is* possible.

Temperature charts were exhibited, showing the pronounced reactions produced by different strains of virus which had been attenuated so as to produce a definite though controllable form of horse-sickness. A small percentage of the horses inoculated in this manner proved refractory, but I am satisfied that if a horse fails to react to large doses of this vaccine, he will prove refractory to the conditions of natural infection.

I am satisfied that if modified attacks of horse-sickness confer any substantial degree of immunity (a point on which all workers with the disease seem agreed), the main difficulty of *producing with safety a modified attack of horse-sickness* has been overcome.

Whether the horse can be as safely passed through this modified phase of the disease in the warm weather, whether a further inoculation of a stronger or less attenuated virus will be necesary to ensure resistance, how long the immunity acquired from the mild attack will last, and whether it will be necessary to adjust a vaccine to different localties, are all questions besides many others which future observation must decide.

My resources in time, help, and material, have in the past been straightened, but now more adequate facilities are at command, and I hope future progress will be commensurate with broadening opportunities. I have intentionally refrained from referring to details of technique, and with my reasons for reticence in this respect, I believe you will not be found to disagree. Much more extended observation is necessary to prove its practical usefulness, and to bring to light and correct its drawbacks. Our monetary loss in Natal during the past season has been at least £12,000, and £50,000 is a small estimate of the loss to South Africa, but apart from economic considerations—the mass of animal suffering reflected in such figures, is sufficient to render the hope of devising some alleviation for the same an ambition for any man.

We can safely say that the successful man will owe as much to the efforts of others as to his own endeavours, for investigations of this sort are progressive and one worker builds on the foundation of his predecessor.

2—THE ORIGIN OF THE FLORA OF SOUTH AFRICA.

(A Sketch.)

By Professor S. Schönland, Ph.D., M.A.

The question of the origin of the angiospermous Flora of South Africa has been dealt with by many authors, ever since Dr. (now Sir) Joseph Hooker referred to it in the year 1859, in his well-known "Introduction to the Flora of Australia." As a rule, it has been treated as a side-issue, and, moreover, the authors who concerned themselves about it were as a rule largely influenced by what is known of the development of the Floras of the Northern Hemisphere. In his "Entwicklungsgeschichte der Pflanzenwelt seit der Tertiärzeit," (Leipzig 1879, 1882), Professor Engler has dealt with it in the most cautious and reserved manner, and even quite recently he has expressed himself to the effect that the relations of the Flora of South Africa to the Flora of Australia, are a great enigma, relations which have to be explained, if one wants to get a true understanding of the origin of our Flora. The difficulties of dealing with this subject satisfactorily are very great, and the data for a final solution are absent at the present time, and may be for ever hidden from us. However, there are a good many facts known which make it at all events probable that the development of our Flora has taken place along certain lines, which I propose to bring before you to-day. It is impossible in a short paper to deal exhaustively with the evidence on which my conclusions are based, but I hope to be able to publish this evidence at no distant date. Any theory accounting for the origin of the South African angiospermous Flora must take cognizance of the fact that no traces of a glacial period have been discovered in South Africa later than Permian times. I am aware of the fact that Passarge thought to have discovered proofs of the former existence of pluvial periods in the Kalahari, corresponding to the glacial periods in the Northern Hemisphere, but I think that his evidence must be looked upon with suspicion, and that while it is certain that rainy periods have occurred, even in the Kalahari, they can in no way be correlated with the glacial periods of the Northern Hemisphere, and that, broadly speaking, the climate of South Africa has, within certain limits, been constant at least since early Cretacous times. This view, which I came to from consideration of purely local facts, is also held by Professor J. W. Gregory, and it is important that it should be confirmed by such a high geological authority, because this view implies that the glacial periods in the Northern Hemisphere have been due to local causes, and not to extra-terrestrial causes such as e.g., a change in the inclination of the ecliptic of the earth. We may also state that there are no facts known which would lead us to the conclusion that there has been a considerable Southern extension of the African Continent since early geological periods, at all events not since Cretaceous times, and we may therefore come to the conclusion that the ancestors of a good many types of plants now found

in South Africa have been there most likely from Cretaceous times. In the Northern Hemisphere, and also in Australia, angiospermous plants have been discovered in lower Cretaceous strata. We know for a fact that the period of the drying up of the huge lakes which occupied the interior of South Africa during Triassic times, coincides with a remarkable development of the higher animals in South Africa, and it seems reasonable to conclude that a corresponding development must also have taken place in the vegetable kingdom. If it is objected that we find no fossil evidence for this statement, I may point out that even in Europe and other well explored parts of the world, we only know well preserved remains of *forest* plants in Cretaceous and Tertiary deposits, chiefly trees and shrubs. We scarcely know any remains of plants from the undergrowth of forests, and scarcely any from treeless and shrubless formations, and yet these must have always existed. The absence of palæontological evidence for our hypothesis is therefore not quite so serious as appears at first sight.

The present composition of the angiospermous Flora of South Africa points clearly to the conclusion that it is of extreme antiquity. In South-Western Cape Colony especially we find a large number of isolated types, a considerable number of endemic genera, huge numbers of endemic species, and even a few endemic natural orders. We find, further, in the Karroo districts, another highly specialised flora which is adapted to certain extreme conditions of climate. We can even find traces of such high specialisation further north, at all events as far north as the Cunene River. We have, therefore, the curious phenomenon that the South Western Flora is, as it were, boxed up in a comparatively limited area, beyond which escape is practically impossible northwards as the conditions in this direction are adverse to it. As these conditions must have existed for an immense period of time, it seems quite out of the question that this peculiar flora should have been derived from a northern scource. Now it is a further curious fact, which has been insisted upon ever since Hooker published the essay previously referred to, that a great many of these types find their chief development in South Africa and Australia. Consequently a common origin of many important constituents of the floras of these two countries has been stipulated by many authors. Some of these types, such as Proteaceæ, were supposed to have originated in the Northern Hemisphere, but the most competent authorities have declared the evidence on which this conclusion was based to the worthless, and the conviction is more and more gaining ground that not only the Proteaceæ, but a great many other angiospermous plants have had their origin in the Southern Hemisphere. Hooker had already pointed out that the many bonds of affinity between the Southern floras, namely, the Antarctic, Australian, and South African floras, indicate that these may all have been members of one great vegetation, which may once have covered a southern area as large as the European Flora does in the north. However, he in no way commits himself to the statement

that they must have had an Antarctic origin, a view which is frequently attributed to him and was even held by Charles Darwin. If my views as to the former climatic conditions of South Africa are correct, then there was no possibility for an extensive development of phanerogamic plants in the Antarctic regions; further, if these views are correct there was no connection between Antarctic regions and South Africa.

The relationships of the Flora of South Africa to that of Australia have sometimes been exaggerated. On the other hand, the more one studies these relationships, the more one comes to the conclusion that they are indeed very great. They do not only refer to the orders which are usually quoted, namely, the Proteaceæ, Compositæ, Irideæ, Haemodoraceæ, Buettneriaceæ, Polygalaceæ, Restiaceæ, Ericaceæ, Epacridaceæ, certain tribes of Papilionaceæ, Rutaceæ, Thymelæaceæ, Santalaceæ, and anthospermous Rubiaceæ, but a close relationship is also found in certain tribes of Cyperaceæ, in certain grasses which have no northern direct allies, in certain tribes of Liliaceæ, and in other natural orders. In all these cases we find that the relations of the two floras are plainest if we compare the flora of that little corner in south-western Cape Colony with the flora of temperate Australia. There seems to be no escape from the conclusion that at one time there was a direct land connection approximately in the latitude of South Africa between South Africa and Australia, and that this land connection disappeared and left traces of its flora both in South Africa and Australia. Now it is generally admitted by geologists that such a land connection existed in Permian times, a theory which was first brought forward by the late Mr. H. F. Blanford, in the year 1875. A direct land connection between South Africa, Madagascar, and India through Ceylon is admitted to have persisted right into the middle of the Tertiary period; it is further admitted, especially on zoo-geographical evidence, that by that time the direct connection between South Africa and Australia had disappeared. Since the causes which led to the excavation of the Indian Ocean must have acted gradually, and probably did not act evenly, I see nothing in the way of assuming that in Cretaceous times, and perhaps even somewhat later, there were still such considerable remnants of the ancient Austro-African Continent, as to allow the interchange of plant types between Australasia and South Africa.

As the land receded more and more in the Indian Ocean, it was more and more restricted to tropical conditions, and consequently those plants which could not accommodate themselves to these conditions died out; remnants of them only being left in those parts which retained a temperate climate. It is a curious fact that Australasia further shares a number of types of plants with the extreme southern end of America, and to a certain extent with its western coast lands as far as Chili. Amongst these there are a few of those types which we found to be common between Australia and South Africa. On the other hand, we do not find in South Africa any

types of plants which would point to a direct connection of the most southern portions of America and Africa. It seems, therefore, most likely that these common types have been derived by way of Australia; that there was a land-connection between Australia and temperate South America after the connection between South Africa and Australia was broken. The evidence for this statement is chiefly to be derived from zoo-geographical facts, and it seems that South America did not get these plant-types until after the time when marsupials had reached Australasia, and got a chance of spreading from Australasia to South America. One fact seems particularly convincing, namely, the finding of the remains of the Tasmanian wolf in Patagonia, remains which cannot be distinguished from the present living species.

Coming back now to our South Western Flora, it seems strange that it should not have had a better chance of spreading eastwards, for although its main distribution now is in the region of winter rains, there can be no reasonable doubt that left to itself it would have a very good chance in the region of uncertain rains, at least as far as East London, and probably beyond it. Here it meets with competitors from tropical Africa, and it appears that these are later intruders. There seems to be same evidence that the typically western flora once spread much further east as far as East Pondoland. Whether the receding of these elements is due to earth movements along the coast, which created conditions that allowed the tropical African flora to penetrate further west, or whether it is due to other causes, is at the present time difficult to decide. In any case, there is no doubt that such earth movements have taken place, and with the lowering of the mountains since Cretaceous times, it is quite possible that the tropical African coast flora has a better chance of fighting its way westward than it had in Tertiary times. Whether the majority of the carroid elements of the flora of South Africa can be referred back to the time when there was a connection between South Africa and Australia is very doubtful; on the whole, their affinities seem to indicate that these elements are younger. As one would expect also from a consideration of geological evidence, there seems to be no doubt that the conditions favourable for such plants were only gradually evolved since Cretaceous times. Many of them have representatives in Australia, but in such small numbers, that it is quite possible that they were derived in Australia from the north, and the affinities of them are, generally speaking, more with tropical plants and even plants of other countries, thus very little that is definite can at present be said about them. Some of them must be looked upon as mere outliers of the tropical African Flora, and the question of their origin resolves itself generally into the question of the origin of the tropical African Flora. I will deal with this question very briefly, though it must be pointed out that apart from the South-Western Flora and the types which may be included amongst the carroid plants, the remainder of South African plants probably

equals, if it does not exceed, the others in number of species, and certainly occupies a much greater area. It consists largely of outliers of the tropical African Flora. Now I may here recall the fact that it is assumed that up to eocene times, tropical Africa was connected with India through Madagascar; further it is assumed that the whole of the Soudan was covered by an extension of the Mediterranean Sea, and that there was probably a more or less direct land-connection with tropical South America. We need not, therefore, be astonished to find that a large portion of the tropical African Flora, although largely composed of elements peculiar to this part of the world, has close affinities with the Indian and Madagascar flora; we also find, especially in Western Africa, some genera the other species of which are to be found in the corresponding formations of tropical Africa, and not only some genera but even whole families and tribes are developed only in tropical America, and either West Africa, or in the whole of tropical Africa. Thus we can picture to ourselves how South Africa also received in comparatively recent geological periods elements of the tropical American Flora, just as there was an interchange of animals between these two regions (I need only refer to the Edentates and fresh-water fish). The supposed former distribution of land and water also throws light on the question why so few European types of plants have formed an integral part of the Flora of South Africa. While South African plants have migrated far north of the Equator, European plants have not advanced correspondingly far to the south, and there is little noteworthy in this fact, if the existing climatic conditions have persisted through previous geological ages, for the South African genera are characteristic of a warmer climate than the North-Temperate forms and are, therefore, so much better suited for an advance into a tropical region than the North-Temperate plants would be. Hooker specially points out the South African character of the Sub-Alpine Flora of Kilimanjaro, but Engler mentions that the boreal elements besides the Mediterranean have many species in the microtherm plant-formations of the high mountains of Africa, while these are relatively poor in plants originating from African types. A fact, which seems to corroborate the views here brought forward, is this, that none of our high mountains in South Africa contain Alpine plants of the Northern Hemisphere.

3—SOME OBSERVATIONS ON ENTOMOPHILOUS FLOWERS.

By R. Marloth, Ph.D., M.A.

Of the three principal agents upon which plants depend for cross-pollination, *viz.*, the wind, the birds, and the insects, almost nothing is known as yet about the rôle which the last named visitors play in this respect in South Africa.

A little more has been done in recording such observations with regard to the birds, the number of flowers which are known to be ornithophilous being already very considerable, although the list is far from complete. My records comprise twenty genera from various families. The more common of these are *Melianthus, Cotyledon, Rochea, Erythrina, Erica, Duvernoia, Tecomaria, Leonotis, Salvia, Selago, Protea, Leucospermum, Mimetes, Loranthus, Strelitzia, Aloe, Kniphofia, Lachenalia, Watsonia, Antholyza, Gladiolus, and Babiana.*

On the other hand, in spite of the floral wealth for which South Africa is famous, the insect-life, which depends upon flowers for its sustenance, has received little attention; at least, apart from a few stray notes, almost nothing has been published on the subject. European botanists seem to think, that this is principally due to the indifference of South African observers. To some extent that may be so, but there is another remarkable feature of the subject, which is largely responsible for this lack of information in South Africa.

Local botanists as well as entomologists have repeatedly noticed, that often there seems to be an entire absence of insect life, although the fields or the hillsides may be aglow with flowers.

One may sometimes wander about for hours among thousands of flowers of *Oxalis, Mesembrianthemum, Arctotis, Dimorphotheca, Cryptostemma, Gazania,* and many others, without discovering a single visitor. There are some species of most common occurrence in the South-West, as e.g. *Belmontia cordata* (E. Mey), a little spring annual with bright golden stars, on which I have never seen a single insect as yet, although I have watched thousands of its flowers every year. Everyone knows the beautiful blue Disa (*D. graminifolia*, Ker), which appears at the end of summer on the south-western mountains in enormous numbers. Although I may have seen hundreds or thousands of its flowers every year, I have, in the course of 20 years, only on three occasions observed an insect actually visiting the plant.

On the other hand, there are some kinds of flowers which form, so to say, regular food-depôts for bees and other insects. The various kinds of aloe, which mostly flower in winter and spring, are often swarming with bees, and the beekeepers of the aloe districts, or the natives who watch the nests of the wild bees, secure an ample harvest of honey at that season.

It will be best for us to arrange the few observations that have been recorded according to the natural orders of the plants.

CYCADACEÆ.—*Encephalartos villosus*, Lehm. Pollination probably effected by a beetle, *Phloeophagus hispidus* Schl. (See Pearson in Trans. S.A. Phil. Soc., Vol. XVI., 1906).

ARACEAE.—*Zantedeschia aethiopica* (L.) Spreng. (*Richardia africana* Kth.) Numerous beetles and flies hide in the bottom of the spathe, and stay there for several days, as observed by Mrs. Solly, who found 8 different species of insects on this plant. Among them were *Anisonyx longipes*, and

LILIACEÆ.—*Agapanthus umbellatus* L'Hérit, visited by *Pangomia rostrata*.

Aloe ferox Mill, *A. ciliaris*, *A. striata*, *A. arborescens* Mill, and many other species, are regularly visited by bees.

HAEMODORACEAE.—*Wachendorfia paniculata* L. and *W. thyrsiflora* L., visited by *Pangonia angulata* (*fide* L. Peringuey).

AMARYLLIDACEAE.—*Haemanthus tigrinus* L. and *H. coccineus* L., are often visited by *Meneris Tulbaghia*, also by birds.

Nerine sarniensis Herb. by the same butterfly.

Hypoxis stellata L.f., by *Anisonyx longipes*.

IRIDACEAE.—*Watsonia Meriana* Mill. *Mycteromia rostrata*.

Antholyza Merianella L., the same.

A. nervosa Thunb. by *Papilio demodocus*.

Bobartia spathacea Ker, by *Lytta nitidula*.

ORCHIDACEAE.—*Disa uniflora* Berg, by *Meneris Tulbaghia*.

D. graminifolia by *Pangonia*.

D. ferruginea Swtz., by the same butterfly, which, at least on Table Mountain, confines itself to the scarlet summer and autumn flowers.

PROTEACEAE.—*Protea grandiflora* Thunb., *P. mellifera* Thunb., and several other species; *Leucospermum conocarpum* R.Br., and *L. lineare* R.Br., visited by *Mylabris lunata*, *Trichostetha fascicularis*, and *T. capensis*.

HŸDNORACEAE.—*Hydnora africana* Thumb., by *Dermestes vulpinus* (See Marloth in Trans. S.A. Phil. Soc., Vol. 1907).

AIZOACEAE.—*Mesembrianthemum nobile*, *M. tigrinum*, *M. edule* L., *M. acinaciforme* L., and many others, by bees and flies.

PORTULACACEAE.—*Anacampseros Telephiastrum* D.C., and other species, by *Sirphus capensis*.

RANUNCULACEAE.—*Anemone capensis* L., by various small beetles.

CRUCIFERAE.—*Heliophila pilosa* Lam., by bees.

DROSERACEAE.—*Drosera cistiflora* L., and *D. capensis* L., by *Anisonyx Ursus*, and other hairy beetles.

RORIDULACEAE.—*Roridula dentata* L. and *R. Gorgonias*, by some *Capsidae*, viz. *Pameridea Roridulae* (See also Marloth in Annals of Bot., Vol. XVII., 1903).

CRASSULACEAE.—*Crassula pyramidalis* L., by *Phasis thero*.

C. portulacea Willd., by bees.

Rochea coccinea D.C., by *Meneris Tulbaghia*.

BRUNIACEAE.—*Brunia nodiflora* L., by beetles.

ROSACEAE.—*Rubus pinnatus* Willd., by bees and flies.

LEGUMINOSAE.—*Podalyria, Virgilia, Psoralea, Crotalaria, Dolichos* and other genera are specially visited by large *Hymenoptera*, e.g., *Anthophora concinna, A. rapida, A. farinosa.*
Acacia horrida, Willd., by *Mylabris plagiata, Pachnoda cincta* and *Rhabdotis semipunctata.*

GERANIACEAE.—*Monsonia speciosa*, by *Anisonyx Ursus* and *Pelargonium cucullatum* Ait., by *Pangonia rostrata.*

OXALIDACEAE.—*Oxalis cernua* Thunb., by bees.

ZYGOPHYLLACEAE.—*Zygophyllum foetidum* Schr., by *Julodis Klugi.*

RUTACEAE.—*Agathosma* species, by bees and beetles.
Diosma vulgaris Schlecht., by bees.

POLYGALACEAE.—*Polygala myrtifolia* L., by bees.

EUPHORBIACEAE.—*Euphorbia Caput Medusae* L., by bees and flies e.g.

CELASTRACEAE.—*Gymnosporia buxifolia* Szysz.. and *Cassine capensis* L., by various flies.

RHAMNACEAE.—*Phylica stipularis* L., and *P. buxifolia* L., by *Leptonura Clytus.*

TILIACEAE.—*Grewia occidentalis* L., by *Anthophora.*

UMBELLIFERAE.—*Peucedanum Galbanum* Bth. et Hook., by bees beetles and flies.

PLUMBAGINACEÆ.—*Plumbago capensis*, by *Chaerocampus capensis.*

ASCLEPIADACEAE.—*Stapelia grandiflora* Masson, and some other large species, by green carrion flies (*Lucilia*), which visit these flowers not only for the sake of food, but deposit also their eggs on them.
St. variegata L., is visited by some grey flies.

BORAGINACEAE.—*Lobostemon glaucophyllus* Buek., by bees and beetles, viz. *Anisonyx Ursus.*

VERBENACEÆ.—*Selago serrata* Berg, by beetles and *Lycaena.*

LABIATAE.—*Salvia africana* L., by several kinds of small bees.

ACANTHACEÆ.—*Duvernoia adhatoides*, by *Anthophora.*

CAMPANULACEAE.—*Lobelia pinifolia* L., by *Papilio demodocus.*
L. Erinus L., by *Lycaena.*

COMPOSITAE.—*Gazania pinnata* Less., *Arctotis acaulis* L., and other species of these and allied genera, by *Anisonyx Ursus* and other hairy beetles, which visit them in day time, and often sleep in the flowerheads during the night or rainy weather.
Dimorphotheca pluvialis Moench, by *Empis bevillata.*
Othonna tuberosa Thunb., and other composites, by *Acraea horta.*

LIST OF INSECTS.

LEPIDOPTERA.

Acraea horta L., *Chaerocampus capensis*, L., *Leptonura Clytus* L., *Lycaena*, Sp., *Meneris Tulbaghia* L., *Papilo demodocus* Esp.

COLEOPTERA.

Anisonyx longipes L. *A. Ursus* Fabr. *Dermestes vulpinus. Julodis Klugo* Cast. *Lytta lucida* Haag. *L. nitidula* Fabr. *Mylabris lunata* Pall. *M. plagiata* Pall. *Pachnoda cincta* De Geer. *Phloeophagus hispidus* Schl. *Rhabdotis semipunctata* Fabr. *Trichostetha capensis* L. *T. fascicularis* L.

HYMENOPTERA.

Anthophora (*Podalirius*) *concinna* Klug. *A.* (*Podalirius*) *farinosa* Klug. *A. rapida* Smith.

DIPTERA.

Empis bevillata Wied. *Mycteromia rostrata* L.. *Nemestrina longirostris* Wied. *N. Westermanni* Wied. *Pameridea Roridulae* Reuter. *Pangonia angulata* Wied. *P. rostrata. Sirphus capensis.*

[The author will be glad to receive specimens of flower-visiting insects together with the flowers.]

4—ON THE HOMOLOGY OF THE MAMMALIAN ALISPHENOID BONE.

By R. Broom, M.D., D.Sc., C.M.Z.S.

By the older writers, the Alisphenoid bone was looked upon as serially homologous with the exoccipital and orbitosphenoid, forming the principal part of the neural arch of the basisphenoid segment or vertebra, as these others do of the basioccipital and presphenoid segments. Though the old theory of Owen and others was pretty effectually disproved by Huxley and Parker, it affords such a convenient way of looking at the mammalian skull at least, as admitted even by Huxley, that in all our text books it seems to be tacitly assumed that the alisphenoid bone is a lateral outgrowth from the basisphenoid, formed to support part of the brain. Even a study of the development does not at first sight seem to be against such a view. The back part of the parachordal forms at its lateral development behind the auditory capsule the exoccipital, and in front of the capsule there seems to be formed in a similar way the alisphenoid.

When we turn to comparative anatomy, we find a rather remarkable circumstance in that, while in the bird there seems to be a well developed alisphenoid, there is no trace of an alisphenoid in most reptiles. In the crocodile, the bone appears to be present in a fairly well developed condition; in chelonians there is a very small bone which some regard as an alisphenoid, and others as a *columella cranii*, but in the lizard and *Sphenodon*, there is no trace. In snakes there is a small alisphenoid bone. In amphibians no alisphenoid can be identified. In bony fishes a distinct alisphenoid is believed to be present, but, as with a number of the other cranial bones, the homology with the bone called alisphenoid in the mammal is extremely doubtful.

It will thus be noted that in most reptiles and amphibians, there is no trace of an alisphenoid, but that it appears in the more specialised forms, such as crocodiles, snakes, chelonians, and in birds and mammals. And the question arises: how did it originate?

If we look at the Sauropsida alone, we observe the very curious circumstance that almost invariably there is present either a *columella cranii* or an *alisphenoid*, but never both. And this holds good for extinct reptilian orders, as well as recent. The lizard has a *columella cranii*, but no alisphenoid; the allied snake has an alisphenoid, but no columella. The crocodile has only an alisphenoid; *Sphenodon* has only a columella. The chelonian has a bone which might equally well correspond to either. One might, therefore, readily suspect that the *columella cranii* is the homologue of the alisphenoid, or in other words, that the alisphenoid is a modified *columella cranii*.

This view, which I have held for a good many years, receives very strong confirmation from the condition of affairs in the mammal-like reptiles. In the very primitive reptiles, of which *Procolophon* may be taken as a type, we have a lizard-like columella cranii. In the early types, which have specialised along the mammalian line, such as the Therocephalians, we still have a columella cranii. In

the even more mammal-like Anomodonts, such as *Dicynodon* and *Oudenodon*, there is a columella cranii, but no alisphenoid. When we come to examine the Cynodonts—those remarkable reptiles, so very nearly related to the mammals as to be regarded by many as the group ancestral to them—we find a broad flattened bone, which most anatomists would not hesitate to call the alisphenoid, and yet, there can be little doubt, it is only the columella cranii of the anomodont flattened out.

Probably the reason why the columella cranii is generally held to be a distinct structure from the alisphenoid, is that the two appear to develope differently. The former is manifestly or apparently a development from the pterygoid bar, and hence it is frequently called the epipterygoid. It is thus a part of the first arch. The alisphenoid is usually supposed, on the other hand, to be a part of the cranial wall.

In both mammals and birds, it is difficult satisfactorily to study stages sufficiently early to show clearly the origin of the alisphenoid. In the developing marsupial, however, the appearances are very unlike that usually figured in higher mammals. In the primordial skull of a *Trichosurus* embryo, measuring 10 mm. in greatest length, the appearances are very remarkable. At a little distance outside of the trabeculae, and opposite the pituitary fossa, are two short cartilaginous rods, one lying on each side. The long axis of each is parallel to the cranial axis. There is no structural connection between the rods and any of the cranial cartilages. It would seem to serve as a support to the large Gasserian ganglion, and is far removed from any part of the brain. No one would readily suspect it had anything to do with the alisphenoid, but would readily believe it to be homologous with the peculiarly developed epipterygoid of the Chamæleons, being similar in appearance and having similar relations. In the *Trichosurus* embryo at birth, then measuring 14 mm., the little rod is found to have taken on a remarkable development. Its inner side has united with the trabecula, and from its outer side an upward process has developed between the two main branches of the fifth nerve. So far it is all cartilage, but soon it extends further upwards by the addition of a membrane-bone ossification. The ossification is not a distinct bone, but a continuation of the cartilage ossification beyond the limits of the cartilage. I have shown elsewhere that a similar development is found in the Marsupial scapula. The alisphenoid may thus be regarded as a peculiar specialisation of the little cartilage which is apparently the modified pterygoid arch.

The palatine bone begins to ossify immediately in front of the anterior end of the little rod, and the pterygoid as a splint bone on the under side of the front part. The relations of the palatine and pterygoid bones in lizards to the cartilaginous arch are very similar.

Taking into consideration the evidence afforded by comparative anatomy, palæontology and embryology, I think, we are justified in assuming that the mammalian alisphenoid is homologous with part of the cartilaginous pterygoid arch of the reptiles.

5.—SOME OBSERVATIONS IN THE WELWITSCHIA DESERT. *

By H. H. W. Pearson, M.A., Sc.D., F.L.S.

[Abstract.]

Welwitschia is confined to the littoral strip of desert which, commencing near the mouth of the Orange River, extends northwards far into the Tropics. The observations recorded were made in January and February, 1907, in the neighbourhood of Haikamchab and Welwitsch, situated in the most southern area from which the plant is known.†

The Flora of the desert belt (the "Namib") is of a marked desert type, and is mainly characterised by several highly peculiar and endemic forms. The western fringe of the Namib is occupied by sand-dunes, many of which are as much as 200 ft. high. Their vegetation is very scanty, and it appears that the whole phanerogamic flora of the dunes of Walfish Bay comprises no more than a dozen species. Of these, two are of special interest, viz. *Acanthosicyos horrida* and *Tamaria articulata*. The former, a member of the Cucurbitaceae, is well adapted to growth in accumulations of sand, and many of the large dunes owe their stability and, indeed, their existence to this plant, whose deep roots serve as anchors.

East of the sand-dunes, where the surface is hard, the flora is richer in species, though in many localities considerable areas are quite destitute of flowering plants. The vegetation consists chiefly of deep-rooted woody perennials of low habit, and with small leaves. Among these are *Zygophyllum Stapfii*—a very characteristic Namib plant, and one of the surprisingly few succulents met with, *Commiphora saxicola*, *Sarcocaulon sp.*—whose stems are encased in an armour of hard wax, a Bauhinia, a few Capparidaceae, and Blepharids. The grasses are rather numerously represented in sandy places by species of Aristida and prostrate Cucurbitaceæ are not infrequent. The arborescent *Aloe dichotoma* is common among the barren crags of the broken country overlooking the main river-beds.

Welwitschia occurs abundantly on the Namib plateau, and descends the ravines leading down to the deeper river-channels. Its altitudinal range is about 400 ft. Pollination is mainly, if not entirely, effected by the hemipteron, *Odontopus sexpunctulatus*, as has already been described (Nature, Vol. 75, pp. 536, 537). Subfoliar inflorescences commonly occur.

Fertilisation rarely fails and very large numbers of fertile seeds are produced. No germinating seeds, nor young seedlings, were found, and it appears that the conditions necessary for effective reproduction rarely occur.

The Namib flora must be regarded as of great age, and it must be supposed that the climatic conditions at present prevailing in

* Assisted by a grant from the British Association.

† I was accompanied on this expedition by Mr. E. E. Galpin, F.L.S.

S. W. Africa, especially the distribution of the rainfall, have, in their main features, been permanent for an enormously long period. Although now so distinct, the flora is probably derived from the same stock as the Acacia-formation which flourishes to the east of it and in a former period may perhaps have extended considerably to the west of its present limit.

6—THE WALTZING INSTINCT IN OSTRICHES.

By J. E. Duerden, M.Sc., Ph.D., A.R.C.S

7—A PRELIMINARY ACCOUNT OF A COLLECTION OF HYDROIDS, MOSTLY FROM THE NATAL COAST.

By E. Warren, D.Sc.

8—SOME REMARKS ON THE PROTECTIVE RESEMBLANCE OF SOUTH AFRICAN BIRDS.

By A. K. Haagner, F.Z.S.

9—THE GEOGRAPHICAL DISTRIBUTION OF SOUTH AFRICAN SNAKES.

By Dr. L. A. Gough.

10—LAYARD'S BEAKED WHALE.

By F. W. Fitz-Simons, F.Z.S.

II—SOME ERRORS IN THE FEEDING OF ANIMALS.

By H. Ingle, B.Sc., F.I.C., F.C.S.

12—THE MECHANICAL CONDITIONS OF SOILS.

By A. Pardy, B.Sc.

13—AGRICULTURAL EDUCATION IN SOUTH AFRICA.

By E. R. Sawer.

[Abstract.]

Mainly a plea for closer organisation and more concerted action as regards research and education. At present an urgent demand exists for a short and relatively complete training—one which combines thoroughness with precision. It is pointed out that the farmer is not likely to extract much from "solid pages of letterpress" in official publications, but can only be reached by lectures and by brief illustrated pamphlets on single subjects. The author considers that too wide a field of investigation is now being attempted, whereas the farming community only requires the definite settlement of certain paramount questions. In addition a Farmer's Year-Book for South Africa is vitally necessary—for one thing, to avoid overlapping in analytical work in the various Colonies. The author also calls attention to the dangers resulting from amateurs devoid of technical knowledge, being driven by the industrial depression, into attempting farming.

14—COTTON CULTURE IN NATAL.

By J. Kirkman, M.L.A.

15—BACILLUS ANTHRACOIDES IN TRANSVAAL WATER SUPPLIES.

By F. H. Josephs.

[Abstract.]

The "*Bacillus anthracoides* of Huppe and Wood," which was originally isolated from soil, and appears to stand midway between *B. subtilis* and *B. anthracis*, has been isolated in the Transvaal thirteen times from surface wells, from three different streams, on three occasions from sewage effluents, from soil, from dam water, but only once from water from a deep borehole by the author.

[The microscopical appearances, cultivations, and pathogenicity of the bacillus, were described.]

From the knowledge otherwise gained concerning the waters from which this bacillus has been isolated, the author concludes that the presence of *B. anthracoides* in a water-supply is strongly suggestive of contamination, and he is of opinion that the detection of this organism may be of considerable importance in the study of water-supplies, especially in those cases in which pollution occurs at comparatively long intervals.

16—MAN'S INFLUENCE ON CLIMATE.

By T. R. Sim, F.L.S.

Man has the power to exert an influence on climate in several ways. Among these may be mentioned:—

1. A local climatic change is effected by the production of shelter, whether by a wall or hedge, a clump of trees or a larger plantation, in the same way as a mountain affects the climate on its sheltered side. This is often used for the protection of tender horticultural crops.

2. A local climatic change is effected by drainage. Drainage is in common use in agriculture, not simply for drying the land, but also on purpose to make the climate more suitable.

Where levels do not allow mechanical drainage the use of quick-growing trees may answer the same purpose by absorbing the moisture and passing it into the air.

3. A local atmospheric change is produced in towns, and in the neighbourhood of factories, foundries, mines, etc., by the emission into the atmosphere of smoke in sufficient quantity to produce haze and fog, or of gases having a deleterious effect on vegetable as well as on animal life. A smoke "smudge" is used in horticulture to prevent damage from frost.

4. But a much more important change than either of these is effected by the production of abundant foliage, especially that of trees; and by the maintenance of a cool moist canopy thereby.

The result in all cases is the effect of a natural law under which at a high temperature the atmosphere can carry a larger amount of moisture than it can at a low temperature. Consequently, when a warm air-current passing over the sea landward absorbs from the sea its full proportion of moisture, and afterwards comes in contact with a colder surface or a colder air-current, it is no longer able to maintain the moisture it contains, and precipitation as rain follows.

A warm moisture-laden cloud striking against a cold mountain or cool forest has its own temperature reduced thereby, and gives off part of its moisture as rain, mist or dew, while in the forest the natural tendency where there is a mass of foliage overhead and a more or less open space below is to produce under this canopy a considerable mass of an atmosphere much colder and more permanently cold than that existing where the canopy is absent. This coldness is further augmented where the humus produced by decaying leaves forms a deep hygroscopic mass in which every drop of rain that falls is retained instead of running off at once into some stream.

Every degree of cold added means an additional precipitation of rain, dew or mist. Man's action, therefore, in maintaining and in producing forests of a satisfactory class, has a most beneficial climatic effect where, as in South Africa, more moisture is desired, while the opposite is the case in very cold and forest-clad countries.

When, as in South Africa, the total forest area is small, and part is thinned out without such protection being afforded as allows

a dense re-growth to follow, the result naturally is that the former forest atmosphere dries out, the surface herbage becomes parched, and a forest fire sooner or later finds its way in and destroys the remaining vestiges of forest growth.

And where trees are naturally sparse and xerophytic, as in South African thorn scrubs, evolution and the survival of the fittest gradually produce in them an ability to withstand drought or even fire, or to suffer less from it, while undergrowth is annually burned clean off. In such case the effect upon the atmosphere is only what is produced by the foliage itself, and usually that foliage is of the small and gradually disappearing nature characteristic of such localities.

The effect of cover is, then, more pronounced under trees which form heavy canopy and produce much humus, than under trees of lighter canopy, or where humus is scarce .

In South African forestry the trees of light canopy and small humus are usually the Australian Eucalypts and Acacias, trees which often have leaves or phyllodes more or less vertical and consequently of slight protection against insolation, and whose leaves decay slowly and consequently form poor humus. These trees are also of exceedingly rapid growth, and transpire the enormous amount of moisture necessary to allow the fixation of the carbon forming the large amount of leaves and stem. To do so they must draw it from the soil, and it is found, in actual practice, that though these trees do cause a considerable amount of precipitation, their powers of transpiration and evaporation are even greater, and they actually pass off more moisture than they draw. To keep that up a natural water-supply in the ground is required, and it is taking advantage of this fact that has led to the use of certain trees for the purpose of drying swamps. They actually draw the moisture from the ground into the atmosphere and sometimes form a valuable natural drainage where absence of fall prevents artificial drainage being adopted.

The moral of all this is that in South Africa wherever forest is formed or maintained in a sufficiently dense condition and of kinds not too absorptive of moisture, but still sufficiently humus-producing, then the result in regard to the local climate is a reduction of temperature and an increased amount of rainfall or other precipitation, with a slight tendency for these results to be felt to some extent in the surrounding district.

The effect produced by the canopy and humus of trees in dense forest is also produced, though in a lesser degree, by the close vegetation and natural decay of good grass-veld.

That "every blade of grass has its own drop of dew" is absolutely true wherever moisture-laden atmosphere comes in contact with foliage colder than itself, and where there is a dense green sward with a moist undermulch of decayed foliage, the herbage is cooler than the atmosphere during the night, with the result that an immense precipitation takes place. The beneficial effect of this dew has always been recognised, but its volume is often underestimated, especially that from driving mist, which has been shown

by Dr. Marloth to measure eighty inches in two months during the rainless summer on the top of Table Mountain, when collected by rushes standing out of the rain-gauge, as against five inches in the same period collected in an ordinary rain-gauge alongside.

Such a precipitation, collected by the foliage and retained by the humus has an immense effect on the local climate as compared with what happens when the grass is all burned off annually, the humus destroyed by fire, and the moisture-attraction completely destroyed. And this contrast is the more marked when, after many years of veld-burning, and that occasionally out of season, the good grass disappears and there grows instead scattered tufts of weeds, wire-grass, or Karroo-bush, separated by wide stretches of bare surface, usually washed clear of soil or hardened almost like rock. No attraction for moisture exists there; heat is reflected by day and radiated by night, and the consequence is an atmosphere rendered by increased temperature all the more fit to carry all the moisture it may contain.

Now, just as the moist forest-atmosphere has a tendency to affect its immediate surroundings, so also have dry carroid conditions a tendency to spread, through the hot atmosphere being able to carry its moisture further and further away, while at the same time the absence of vegetation on the carroid area renders the pasture-demand on that around it all the greater if the small amount of stock and game in the neighbourhood is to continue to subsist there. The amount of travelling to and fro in search of water and in search of food also tells considerably on what vegetation remains, and tends to further denude and consolidate the intervening surface.

Now, throughout Africa the amount of nearly bare Karroo is enormous, and its proportion to the whole area is so great, while that of forest and even of good grass-veld is so small, that the total tendency is toward an extension of Karroo and a diminution of forest.

Egypt, Arabia and Persia have been transformed in this way from bush country into bare desert. So also in South Africa the grazing of the Karroo, the burning of the grass-veld, and the tramping of stock to and from water, have effected and are still effecting changes in the veld and in the atmosphere which can only end in universal desert, unless means are taken to prevent this.

Moffat, Livingstone, Brown, and others have given warnings based on what they have seen, and any farmer of many years' experience in the districts adjoining the Karroo can relate how the vegetation has altered within his time from a fairly good grass-veld into a condition of more or less decided Karroo. This I have witnessed personally within the past 20 years in almost all the districts of Eastern Cape Colony, where the gradual transition in its various stages has been painfully manifest; while the increasing dryness has rendered the forests retrogressive rather than aggressive, and this effect has been accentuated by the grass fires annually encroaching into the forest margin, and occasionally breaking through and doing damage inside.

In all this there can be no question but that man has at least to a considerable extent, the control of the climate in his power. It is, however, not a local matter influenced by the action of any one individual, but a public question, requiring co-operative action, which best takes the form of Government control, on purpose to check the progress of such wide-spread disaster as threatens sooner or later to overtake the whole of Africa, as it has already claimed much of the Karroo in the south and of the Sahara and Egypt, Arabia and Persia in the north.

It may be asked in what way man can improve matters. The destruction is evident and increasing, but what can be done to stop it without interfering with the present utilisation of the land? The answer is: much, and in many ways.

The culture of crops supplying winter-feed allows what is considered a summer stock of cattle to be maintained all the year round without inflicting hardship either on the veld or on the stock. The disuse of grass-burning and its substitution by paddocks grazed in rotation, but never injuriously grazed, does much to maintain or improve the climatic condition instead of allowing it to drift, while feeding stock by manure-grown crops upon such paddocks gives them a manurial improvement so long as the grazing is in moderation and beef or wool the only crops removed.

The popular prejudice in favour of grass-burning is only related to pastoral agriculture, which is now rapidly giving place in most localities to more intensive farming; and the latter requires the adoption of methods specially fitted for its use, and the abolition of such methods as no longer fit the altered practice.

The production of abundant foliage, by whatever means, has a tendency in the right direction, so long as the soil is able to maintain that foliage, and in this respect cultivation plays an important part, but it is more particularly in the enormous extension of plantations of moisture-attracting trees that climatic improvement is assured, or at least that some check can be put upon the rapid desiccation now going on. In Europe 25 per cent. of the total area is considered a fair proportion under forest in order to secure suitable climatic conditions. In South Africa, with its higher temperature and lower average rainfall, even a larger proportion is necessary, whereas the actual area under forest of all kinds is much less than one per cent.

Even much of the existent plantation-forests consist of varieties of doubtful advantage in this respect, their rapid growth causing more moisture to be used than is attracted by them. But even there an advantage is gained in this, that winds dried out by contact with such plantations naturally become warmer and lighter by the loss of their moisture and rise, leaving their places to be filled by further moisture-laden clouds from the sea, and thus a constant pumping arrangement from the sea on to the land is automatically produced; this also applies to all forests.

As already mentioned, the kind of tree used for plantation work materially affects the result from a climatic point of view, and in this the quick-growing and consequently rapidly remunerative kinds are the least beneficial. Slow-growing species, producing dense canopy and much humus are the most useful climatically; hence, since these are so long in bringing in returns that the private planter omits them from his plantation, there is the more reason why the various Governments should act energetically in forming large plantations of these kinds, even if paid for from loan funds as is done in Cape Colony, on the principle that it is expenditure which will ultimately be remunerative. Of that there cannot be any doubt if the work is skilfully and economically performed, even apart from the question of climate, but the climatic importance is so great as to practically outweight all other considerations and warrant even huge expenditure. The drying out of South Africa is at present going ahead at an enormous and rapidly increasing pace, much accelerated by the methods of pastoral agriculture in use; cattle diseases have rendered that form of industry unremunerative or doubtfully and irregularly remunerative; intensive culture and rotation-grazing are steps towards production without prejudicial effect on the climate, but it is in plantation work, and especially Government plantation works of slow-growing and humus-producing kinds of trees that any guarantee (or even precaution) against increasing desiccation lies.

SECTIONS E AND F.

Education, Philology, Psychology, History, Archæology; Economics and Statistics, Sociology, Anthropology and Ethnology.

Sections E, and F.

1—PRESIDENT'S ADDRESS.

By R. D. Clark, M.A. (Oxon.).

I cannot deal with the topics that I have deemed fit to bring before you on this occasion without first giving expression to the deep sorrow which I am sure we all share in that the eloquent voice of the Prince of modern British scholars, to which we were privileged to listen last year in this Section, has since been stilled in death. I little thought that when first I met the late Sir Richard Jebb that the next time I should meet him would be well into the twentieth century, gazing on the South African veld with cultured curiosity at a native marriage-dance, and trying to square the new experience with the wealth of lore he could bring to bear on it.

At a hint from me that it might shed some light on the function of the chorus in Greek Tragedy, his eyes lit up, and but for the fact that he had then, alas! a foot in the grave, the idea might have born rich fruit. . . . . Requiescat in pace, and may Bentley, Porson and Jebb be minded for a pleasure trip when I have at last saved the three obols necessary for paying Charon to ferry me across the Styx.

Now it is to the breaking down of the misconception that science or scholarship or its last and highest stage, culture, are incompatible or antagonistic, that an Association such as ours lends itself. Its catholic scope can be gathered from a conspectus of its various sections. Taken together, they virtually imply a knowledge of what is in heaven above, what is on the face of the earth underneath, and what is in the matter of the earth itself. Each individual is the centre of all the phenomena of which he is cognisant, and other things being equal, he will live best who knows the most regarding their nature and laws. In this respect knowledge is indeed power, the power to command the highest good of all, viz., the good life. The difference between knowledge and ignorance is just this: the former enables us consciously to work together with Nature's forces alike for our own good and the good of others; the latter lets its unhappy victim unconsciously work against them to his own undoing and that of those with whom he comes in contact. I can attach no other meaning to St. Paul's sublime conception of the creature being exalted to being a co-worker with the Creator, than this, that it is the high calling, the only royal road to which lies through the acquisition of knowledge. Ignorance is mankind's greatest foe, a fact which makes education the paramount concern of individuals as well as of States. This was enunciated by Aristotle in his *Politics* some twenty-two centuries ago, where he says that the legislators'

main concern should be the education of the youth of the State. It is humiliating to note that owing to party rancour and religious prejudice the greatest legislature on this globe is powerless to deal effectually with its most pressing problem. Looking round the world to-day, there are two countries that are the cynosure of all, on the score of great achievements gained solely by unremitting attention to the thorough education and training of their youth and manhood. One is the great German power on the Continent of Europe, and the other the rising star of Japan in the East. Germany's *Wissenschaft und Fleiss* have put her into the saddle so firmly that nothing that has yet appeared can possibly dislodge her. She is closely rivalling the commercial and industrial supremacy of Great Britain, whose petulant and hysterical alarm almost appears symptomatic of decadence. The schoolmaster and the professor have made Germany, and they are as a result not without honour in their own country. They rank with the princes of the land, whereas in some other parts of the world which we wot of, a subaltern of a marching regiment has a status far superior to that of an assistant schoolmaster. The teaching profession will never be on a satisfactory footing until the status and emoluments of its members be such as to command the best breeding and the best brains of a country.

But the teacher himself should have a preparation adequate to his high calling. Mere academic equipment alone, and an empirical knowledge of educational methods, are not sufficient. Psychology and physiology are as requisite for him as are chemistry and anatomy for the physician. The training of its teachers is as important a concern to a nation as the training of its citizens, for the one is dependent on the other. There is, in my opinion, no branch of instruction of more importance at the present moment than that in the rights and duties that attach to citizenship, and no question is more in the air, both in this Colony and in the Mother Country, than the duty incumbent on every citizen to fit himself for defending it. We still retain the insular prejudice against Continental conscription, but modern conditions alter with astounding rapidity, and we may yet have to yield to the inevitable, and adopt the principle, by whatever name it may be called. Repentance may come too late when the Goth is at the gate. Any country worth living in is worth defending, and the sooner we wipe out the reproach that we are only a nation of shopkeepers, with a mercenary army, the better it will be for us. Half a century ago Japan was still what Montgomery wrote long before:

> "Zealous China, strange Japan,
> With bewildered thought I scan,
> They are but dead seas of man."

Her national training and her national spirit have put her to-day in the foreground of the great World Powers. Again, I say, "Britons, awake!" It is, of course, disappointing to know that it was the man who wrote "*Dulce et decorum est pro patria mori*," who, when a chance was afforded him of doing so, ran away and lived to

tell the tale. Still, when that sentiment no longer pervades the heart of a nation, it is on the down grade, and must give place to some more virile and patriotic people. The political problem for South Africa, to the solution of which the section over which I have the honour to preside will be one of the chief ancillaries, is that of turning its people into a nation. That has already been achieved in the case of Canada, and virtually so in Australia. The best exponent of this process is Mr. Richard Jebb, whose book on this topic should be the *vade mecum* of every one of our South African statesmen and educators. It is now some thirty years since Lord Carnarvon made his famous attempt to impose Federation artificially upon us from without, but this, as bitter experience has shown, is, like the Kingdom of Heaven, within us or is nowhere at all. Now I am one of those who are robust believers in the not-far-distant realisation of this cherished ideal, and it grieves me to have to say that according to my poor lights, our greatest modern South African, Cecil Rhodes, lost a golden opportunity of accelerating the hands of the clock in this regard. *Pace* Sir Lewis Michell, I count it as little short of a national calamity that instead of sending home a scratch lot of Colonists to learn to run and jump imperially, he did not carry out his original and pious project of devoting his colossal fortune to the foundation and endowment of a teaching University under the shadow of Table Mountain, or on some other central site. For one man who will lend himself generously to the precious influence of the *genius loci* of Oxford, there would have been scores of young South Africans carrying away with them from a local teaching University into every corner of the sub-continent the spirit of *camaraderie* and the priceless germs of national aspirations. I have long watched with pleasure the great work that the South African College has already been able to do in this respect. A very valuable contribution to the literature of this subject has been recently made by Professor Hertz, of the Transvaal University College, in his paper on "The Functions of the Modern University."* It is the most up-to-date utterance on this all-important theme that I have come across. Thanks to the energy and ability of the Superintendents of Education in the different Colonies, a complete supply of primary instruction is all but an accomplished fact, but our secondary schools are still in want of the coping-stone that a local teaching University would have provided. With this primary instruction, the first rung in the ladder of efficiency for citizenship will be attained, when every child is able to gain knowledge from reading, and to express its thoughts in writing, with enough of the remaining of the "three R's" to be able to say what change is due when a half-crown has been tendered in payment of a debt of, say, 1s. 11½d. I am not sure, however, if the peculiar environments in which our lot in this sub-continent is cast should not, for a time, at least, incline us rather to revert to the old Persian "three R's," namely, riding, shooting and truth-telling. Here, perhaps, as much as elsewhere, truth is at the bottom of the well. Our tropical climate tends to

beget such luxuriant imaginations that one rarely finds it at the top. As to training to the use of firearms, I would not confine it to the youth of the sterner sex only. The ladies of Ixopo have set an excellent example to the rest of the Colony by practising at the rifle range, and surely our Colonial womanhood may legitimately fit themselves to lend their aid in a crisis to the defence of their hearths and homes. Besides, recent events in the precincts of the British House of Commons have demonstrated what splendid material has been lost to Great Britain through ignorance as to the fighting capacity of the so-called weaker sex. For the rest, even in this comparatively young country, the subsequent training, whether secondary or University, should be directed so as to secure the best service to the State. In the best days of Athens the citizens vied with each other to render the greatest gratuitous service, but nowadays the greed of wealth prompts the modern citizen to make false income tax returns, and even to shirk military service. The old adage was much better, "No man liveth to himself, no man dieth to himself, living or dying, ye are the State's." I thrust South Africa will never see the day when Ministers of the various Colonies shall belie the original meaning of their official title, viz., "servants," by making themselves the Colony's masters, with an eye only to the loaves and fishes attached to their office.

I yield to no man in my appreciation of the importance of the branches of science included in the other Sections of the Association, and in admiration of the magnificent achievements therein accomplished for the progress and well-being of the race, but I trust I may be pardoned if I claim that the paramount and proper study of mankind is man, and from the first day I came across Terence's immortal pronouncement "*Homo sum, humani nihil a me alienum puto*," I have held that mere science without the humanities is not the be-all and the end-all of life; for I must confess to sharing Herbert Spencer's apprehension that the moralisation of the race is not keeping pace with its mere intellectualisation.

> "Let knowledge grow from more to more,
> But more of reverence in us dwell,
> That mind and soul, according well,
> May make one music as before,
> But vaster."

It is painful, for example, to see our schoolboys in a suburban train making it impossible for their elders to read a book or paper owing to their noisy, boisterous and irreverent behaviour, even towards our City Fathers and statesmen. Then I fear, too, that Christianity is losing its driving or compelling power, and from a national point of view, is inferior even to the ancient Roman or the modern Japanese religion in this respect. Whatever form of religion produces the most public-spirited and self-sacrificing citizen is the best for any State. Whilst we have been bickering over religious differences, the words of Lucretius seem almost prophetic of the condition of England in this respect: "*Tantum religio potuit suadere malorum.*" We have, in fact, been neglecting the most vital interest of a nation.

namely, the inculcation of the binding claims of Duty, both public and private. This is the key to the efficiency of the Romans as a conquering and a ruling race, and the British Empire will last only so long as its members give duty the first place and self only the second. Duty is the foundation-stone of Sociology, and yet what a lamentably small percentage of us will lift even a little finger for the furtherance of their lips' desire. The solidarity of the race, thanks to the triumphs of science, is being more firmly established year by year, and the prime requisite is conduct directed to the bettering of the individual in all his highest interests, the welfare of the State or Empire, and that of mankind at large.

I hail with pleasure the awakening that is taking place throughout the Empire as to the value and need of technical instruction. The American axe fashioned on Nature's Laws easily ousts its clumsy British competitor from the markets of the world, and this pocket pencil which I hold in my hand from the factory of Johann Faber, in Bavaria, has, for cheapness, handiness and efficiency, no English rival.

Mine is somewhat of a death-bed repentance, but I now see clearly that the smattering of Latin which is all that can be got in most of our High Schools involves a sinful waste of time. It has been argued in defence that memory can be got in the mere acquirement of the rudiments, but as good a memory can be got in the acquirement of a modern language, or the study of the elements of any of the sciences, with the added advantage that something useful for life, which, after all, is the main interest, has been gained. I know that in this view I may seem to some of my friends to be talking nonsense, but I would ask them to reflect on what Shakespeare, with his little Latin and less Greek, has been able to do for the enrichment of the human mind, using only translations of the ancients into English, *e.g.*, "Plutarch's Lives." And if I may refer for a moment to a minor question, I am one of those who are of opinion that if taught at all the pronunciation of it in other than the Continental or Italian method, should be held to be nothing less than a statutory offence.

Let me, in conclusion, endeavour briefly to correlate the topics of our own sections with those that fall under different heads. As human beings, we find we are moving about at the bottom of an aerial sea some sixty miles deep, which envelopes the planet on which we tread, and without which we should be much worse off than fishes out of water. This planet is only one of several solar satellites, while beyond all this is illimitable space, dividing us from the stellar worlds. The modern advances made by the science of Astronomy, enable us to view these wonders without the pessimistic note of Omar Khayyam:

> "And this inverted bowl we call the sky,
> Whereunder crawling, cooped we live and die,
> Lift not your hands to it for help for it
> As impotently moves as you or I."

Reverting again to the solid earth which forms our standpoint, the science of Geology reads for us the riddle of the rocks, and

unfolds to our wondering eyes the marvellous life history of the planet. These two sciences alone, through the immensity of the conceptions they involve,

> "Have power to make the noisy years seem moments in the being of the eternal silence."

The next natural group of sciences will naturally deal with the nature and composition of the Earth's matter, and the means of exploiting it for human benefit, and its artificial reconstructions, whether for utility, as in engineering, or for utility and beauty in combination, as in architecture. The next group will deal with the laws of plant and animal life as we now find them on the planet, whether purely natural, or as artificially modified by human ingenuity and enterprise, and last comes the group that deals with what we modestly call Nature's crowning achievement—Man himself, his powers of speech and thought, and their cultivation, his past achievements in Arts and Arms and Policy, his present economic political and social relations, and his individual and racial evolution, as treated in anthropology and ethnology. The field is vast and the labourers are few, but the division of labour, and the loyal and earnest co-operation among the faithful few have already accomplished much, and is every day by leaps and bounds accomplishing more. It will take a long time before the majority of the dwellers in South Africa can approach with the requisite scientific and literary equipment, say, Tennyson's "In Memoriam," or his Centenary poem on Virgil (which may be taken as the high-water mark of human utterances in these latter days), but it is an ideal towards which, collectively and individually, we must work, and this South African Association, still in its infancy, but stimulated by recent contact with its great British model, has a noble task in front of it.

As to what extent it is either our duty or our interest to allow or encourage our coloured fellow subjects to share in the priceless boon of knowledge, whether technical or general, it is not for me to discuss here. Let us strive with all our might, whether through the agency of school or college, of missions or of associations such as this, for the realisation of a Golden Age which is not yet, when, as the waters cover the sea, knowledge shall cover the fair expanse of a united and prosperous South Africa.

2—THE BEST MEANS OF PRESERVING THE TRADITIONS AND CUSTOMS OF THE VARIOUS SOUTH AFRICAN NATIVE RACES.

(In a form available for future Scientific Research.)

By Rev. H. A. Junod.

[Sargant Prize Essay.]

The native tribes are undergoing rapid changes. Even the most superficial observer must be struck by the fact. Twenty years ago had he passed through the kraals in a remote part of the country with a hunting party, he would have been delighted to see the natives living in their old and picturesque way, clad as children of nature; to-day, if he happens to go to the same place, he finds the men wearing trousers and jackets, sometimes even huge, high, white collars. They all have hats, some of them boots. The women have preserved the old style better, but they all long for covering their body with gowns, and a good many would gladly submit themselves to the injurious habit of stays! Instead of the nice and characteristic conical shaped or rounded hut, square houses of poles or even bricks are built almost everywhere, first by the chiefs and by the christianised natives, but also by heathens.

But it is not only the outside appearance which changes rapidly. The mentality of the tribes also, their ideas, ideals, their customs and habits undergo the same transformation. Of course, the process is slower. A new conception of life is not so easily adopted as a pair of trousers or a white collar. However, the evolution has begun, and it will not stop before it has entirely changed the native. Dr. Bryce, in his "Impressions of South Africa," foretells that in 40 years' time "there will probably be no more pagan rites practised in Cape Colony"; in 80 years, perhaps even sooner, there will be none in Matabeleland, ... if the gold reefs turn out well." If the distinguished economist who wrote these lines is right, the religious and moral change which has already started everywhere, would be completed in the middle of the century, and very little of the old customs would be found amongst the natives at that time.

Let us consider that transformation somewhat closer to see how far it will reach.

The last words of the quotation we have just made point to the real cause of that ethnical phenomenon. "If the gold reefs turn out well." Africa has now become more or less a white man's country. The white man has penetrated everywhere, conquered it entirely, and tried to impart his ideas and his religion, to the natives. Hence the change. The contact between him and his black brother is every day more intimate, the influence already exercised will become more and more predominant. At present three principal agents are acting on the native tribe as a dissolvant, and are doomed to cause, in course of time, the entire disintegration of the old system of Kaffir life: Christian ideals, scientific knowledge, and the European political domination.

I mention first of all the *Christian doctrine and ideals* which the missionaries are teaching all over the country and which spread with a remarkable speed amongst the kraals. Christianity is at the same time a religious doctrine and a moral teaching. When a native, in the dim, sometimes half unconscious act of believing (Kholwa) has adopted Christianity, he has put the axe at the root of an immense tree, and sooner or later the tree will fall. The adoption of the new creed, first of all, ruins at once his own, old religious ideas, viz., the belief in the spirits of his ancestors as being his gods. This ancestrolatry is the first branch of the tree which falls. It falls so quickly that very soon after his conversion the black Christian laughs at the idea that he could have believed such an absurdity. Nothing is more striking than the victory won by the idea of the only God, Creator of heaven and earth, on the old, puerile representation of heathenism. Now, with the ancestrolatric belief, all the customs of the heathen religion will have to fall. No more sacrifices with their sacramental formulas, no more prayers addressed to the deceased forefathers for the welfare of the house or of the tribe. One of the ties which bind together the members of the nation, viz., the idea that common ancestors are the gods of all, will disappear. The moral teaching of Christianity has not such a rapid action as its doctrinal aspect. However, submissive to authority as the native is, he adopts at once the Bible as the guide of his life, when he has converted himself to Christianity, and the Christian ideals, which he is very far from realising at first, take hold of him and alter his conception of right and wrong. Every custom having some immorality in it, according to the standard of the New Testament, will be condemned, and probably abandoned. *Circumcision*, which, amongst the Bantu, is but a grotesque imitation of the semitic rite, accompanied with a vast flow of unclean language; customs of "*bugango*," or free and unchaste relations between young people of both sexes; "*lobola*," or the buying of wives, which is entirely based on the idea that the woman has become the property of her husband and of the family of her husband; *polygamy*, which is but a sequel of lobola, and is, moreover, incompatible with a more advanced civilised stage; the *conception of parental relations* so peculiar to Bantu tribes, with its strange way of considering the parents in law, a set of ideas which is a direct result of polygamy and lobola; all these pillars of the heathen system, all these main branches of the heathen tree have already been partly cut away in native Christian congregations, and will certainly disappear under religious and social influences.

The adoption of Christianity, which will be universal at least in the more advanced South African States before the end of this century, is the most powerful destroyer of heathenism. But a second agent comes in, together with civilisation, with the development of schools, with the beginning of education: *Scientific truth*. It rules the whole of the civilised world. Its action on the mentality of lower races will be slower, because it requires a higher degree of intelli-

gence and culture to be properly grasped. . . . . But it is sure to destroy the childish conceptions of *animism* which are the base of Kaffir philosophy. Amongst the less developed strata of European nations, amongst peasantry, for instance, traces of the animistic theories are still to be found, but they disappear rapidly. The same process will take place amongst the primitive races. What is the main idea of the animistic system? It is this: All the phenomena of nature are produced and controlled by spiritual influences, mostly inimical to the happiness of man. These spiritual causes can be detected by appropriate means, because they act according to certain laws. The law of resemblance is one of the most conspicuous.* It will be found at the base of most of the superstitions of the natives; it reveals itself under hundreds of different forms, and has inspired a great part of their therapeutics. Let the great modern principle of experimental science be instilled into their minds, and all that scaffolding of superstitions, which appear to them most reasonable now, will tumble down at once. There are more than 130,000 native children attending schools throughout South Africa; the teaching they receive enlightens their minds, and though it does not pretend to lead them to the summits of science, it is certainly bound to destroy the animistic theories fancied by the imagination of the savages.

Now, the great upholder of animism is the *mungoma*, the fortune-teller, the man who "smells out" witchcraft. His power is enormous on the bulk of the tribe. He is the adviser of every adult. The little bones of his basket are the Bible of the native, as one of them was telling me. The overwhelming influence of this charmed basket will fall as soon as the natives have got some understanding of the succession of cause and effect, as revealed by scientific experience. I might mention also as having to share the same fate, their mysterious and horrible theories of witchcraft, their scanty cosmographic ideas, and also those strange institutions regarding human life and human growth, which are so deeply rooted in the Bantu mind, and which have given rise to a number of little-known ceremonies. The light of knowledge will certainly, in the course of a long time, dissipate all those shadows of animism from the native soul.

European political domination now established everywhere has done much already, and will do more in the future, to hasten the transformation of the primitive Bantu life. The chief was the very heart of the tribe. Now his influence has been greatly diminished. The fact that Native Commissioners are everywhere discussing and

* Let me give an example of it. We see often, hanging at the neck of natives, a kind of amulet consisting of a shell filled with black wax, and, half inserted in the middle of the wax, 2 or 3 seeds of abrus precatorius. These well-known seeds are like beads: bright red with a black spot; just like little red eyes, the eyes of the seeds appear to look out from the shell...That amulet is worn by people who are said to suffer from bad spirits having taken possession of them. The spirits have been already induced to go away and to leave the patient. But as they are reluctant to obey, these charms put to the necklace of the patient will complete the healing; the bad spirits are peeping out like the seeds and preparing to leave!

judging the more important matters, has lowered the position of the chief. In some places they have been removed because they had been troublesome. To remove a chief is to emasculate the tribe. Any revolt occurring, any trouble caused, will tend to the same result. The wonderful organisation of the Zulu *yimpi*, which was copied by many other tribes, will soon be a thing of the past. The manifold customs connected with it, the wax crown of the men, the high praise of the chiefs sung by their "poet laureate," all those picturesque scenes where assegais and ox-hide shields have a prominent place, will disappear, and the war songs which used to send their frightful clamours to the echoes, will be forgotten by the new generation.

What will the native life be without ancestrolatry, without lobola, without polygamy, without divinatory bones, without witchcraft? What will the native become with chiefs of diminished power and without an army?

The friends of picturesque primitive life will regret the result of that evolution. True friends of natives will recognise that it is an absolute necessity. The disappearance of the old system is the condition *sine qua non* to the adaption of the race to a changed environment. The fact that a great many natives have already consented to it is a proof of the vitality of the Bantu nation. But, if the religion, the mentality, the social life are about to change, the Bantu will remain and the Bantu soul also, and the time will come when the educated South African aborigines will long to know something of their old status. They will have learned that the past explains the present, and that they cannot know themselves properly without inquiring into their previous conditions. It is just the same with us. Barbarians of old, having been transformed under the influence of Judaic Christianity, and of Roman and Greek culture, how much we should like to have a deeper knowledge of our Celtic and German forefathers! We are obliged to be satisfied with very little indeed. The Bantu of the future will be more fortunate. If we educated white people do our duty, science will provide them with a full account of their former, primitive stage.

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To preserve the customs and habits of the Bantu tribes in a scientific form is a very important and very urgent task indeed, and the friends of science, as well as the friends of the natives, can be thankful in seeing that the question is now before the public, and that it is likely to attract more attention in South Africa than it has done before. There is no time to lose. Let us devise the means to arrive at a full, precise, and intelligent description of the native life which is on the verge of disappearing. Only let these means, when pointed out, be used on a large scale, and our generation will have the honour of having done its work well. Science will be thankful to us as the material gathered will be of an immense value to the future Anthropologist, I may even say to the students of humanity.

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The subject before us presents two different aspects, a theoretical one and a practical one. The theoretical aspect of the question is this: It being admitted that science wants a full account of the native life, by what means must the needed work be done? The means here devised are the theoretical means. The practical aspect is this: How can we get that work done? I should include under that head suggestions about the practical means to be employed in order to make existing materials useful, or to collect those which are still lacking (practical means).

PART I.—THEORETICAL METHODS.

Science cannot be satisfied unless it possesses a full and intelligent description of the habits, customs, ideas, folklore, arts and crafts, physical features, and language, of each South African tribe. The complete historical, anthropological, linguistic and physical record can be obtained by the use of four different means: The publication of books, museums, photographs, and phonographs. Let us consider what ought to be done in these four directions.

A. THE PUBLICATION OF BOOKS.

Each South African tribe ought to be described under four or five different aspects, each of which might be the subject of a book of considerable size. These aspects are as follows: Ethnography, Ethnology,* Folklore, Language, Physical Features. Let us try to imagine what would be the best plan in building up that construction.

(1) *The Ethnographical Book.*

It is certainly the most needed of all, because the customs and ideas of the natives are undergoing more rapid changes than their physical features or their languages. I should conceive an ethnographical description as an attempt to understand the *life of the tribe* under its various manifestations, beginning with the life of the individual, and studying then the life of the family and of the kraal, the national life, the agricultural and industrial life, the literary and artistic life, and, as crowning of the building, the religious and moral life.

Dealing first with *the life of the individual member* of the tribe, I would try to give an account of the evolution of the man and of the woman, from their birth to their death. What an amount of material might be gathered all along this career which seems so uneventful to the superficial observer, but which is full of interest when you come to know it in its details: The boy is born, what is done for him, who receives him in this world; how is premature

* In accordance with Topinard in his "Anthropologia," I should use this term Ethnography for the description of customs and ideals, and Ethnology for the history, migrations, relations of the tribes or clans.

or twin birth considered; what is done for the mother ? etc. He begins to grow; what are the ceremonies performed when he first leaves the hut; how is his name chosen; which medicines are used to protect him against evil influences? Children's games and occupations are such an extensive subject that a book has been devoted to them alone by Mr. D. Kidd. Then comes the age of nubility, which is everywhere attended by special and very interesting rites. I should rather treat this great subject of circumcision in the chapter consecrated to the national life, as it is one of its most characteristic manifestations. But the relations between the sexes might be described here. It would lead to the long and complicated marriage ceremonies which present such strange features in more than one tribe. The mature age customs would give us opportunity to search what is the ideal of the native, how he conceives the aims of human existence, how he enjoys it. And then we would consider the old age, death, and the sometimes highly significant rites of burying the dead and what is done to clean the village from the malediction or pollution of death. The evolution of woman, though very similar to that of man in certain domains, possesses peculiar features which might then be exposed. For instance, among many tribes there are peculiar ceremonies performed for the girls at the time of nubility. The legal situation of the married women, and especially of the widow, and the customs related to them, would present a special interest in connection with the problem of polygamy.

The life of the family and of the kraal (as, in Bantu tribes, a kraal is a family after all) could not be made the subject of a long treatise when dealing with the nomadic Bushmen. But amongst Bantu, this would form a very curious chapter. In trying to describe the *life of the family*, one would have to deal with three of the most characteristic features of those tribes: The familial system (or kinship relationship) and the social customs of "lobola" and polygamy. The kinship relationships would best be explained in establishing the genealogy of a given family and asking how each individual names the others and behaves in relation to them. As regards lobola and polygamy, they are far-reaching subjects which present more than a scientific interest. Other questions would arise: What are the causes of divorce? Is it frequent ? What are the relations between the various members of the family, and especially between parents-in-law. Under the title, *the life of the kraal*, we would give an idea of the form of the village, the disposition of its huts, goats, pigs, and oxen kraals; then would follow a description of the activity of the various inhabitants: first the activity of a woman, from sunrise to sunset, the part she has in the manufacture of domestic implements, especially the culinary art, which is much more complicated than one might think. Then the activity of a man, his special duties in the construction of the house, the weaving of baskets, etc., his pastimes, his games, the famous beer-drinkings which occupy such an immense place in the life of the kraal, etc., etc.

The third part of the Book on Ethnography would attempt to describe the *life of the nation*. The *person of the chief* occupies the centre of this subject: The story of his evolution from his birth to his death is a long one; there are special customs observed for him during his infancy; his marriage also is submitted to a number of rules. His crowning, with all its complicated ceremonial, the apparel of his chieftainship, his right of levying taxes, his presiding over the tribunal of the tribe, the respect which he inspires, and which has given rise to many peculiar habits of the tribe, the laws of succession, are some topics to be introduced here. The *court* and the tribunal which gravitate around him ought to be studied with a special care, and it would be extremely useful to try to codify, not only for a practical use, but from a scientific point of view, the native law in each tribe as it has been transmitted from time immemorial. The comparison between those unwritten legislations would throw a very interesting light on the beginning of human social life. A third subject in this part of the book would be the Army, its composition, its mobilisation, its costumes and peculiar weapons, its strategy, its war songs, its special charms, etc. As original impis are to be soon a thing of the past, the chance of getting true information on the military system of those tribes will soon be lost! We would suggest to introduce here an account of the *circumcision rites* as being the recognised and immensely praised initiation by which boys become adult members of the tribe. The knowledge of these rites is an esoteric one, and the heathen try to keep it absolutely secret. But nowadays they do not succeed any more in hiding them, and those who have won the confidence of the natives, especially of the Christianised ones, can easily enough be initiated into all the formulas, customs and ideas connected with that most curious part of the Bantu life.

We should then pass to the *agriculture and industry* as manifestations of the intellectual life of the tribe. Under the title of agriculture the following subjects would present themselves: Land tenure, laws of common property, use and ill-use of the soil, products of the fields, cereals cultivated, fruits and vegetables used, tilling and harvest. Then the cattle-rearing, of which the Bantu are so fond, and which they understand remarkably well. The *industrial life* would include the manner of dressing, the habitation, the implements, the rudiments of trade which can be traced amongst the natives. Each of these subjects requires a good deal of observation.

The *literary and artistic life* would prove a still wider and richer topic. For many people, to speak of literature amongst those primitive tribes is nonsense. But if they have no written literature, they possess any amount of folklore: the materials which one might gather in this domain is so plentiful that I would advise students of South African ethnography to consecrate a special volume to it, as it might destroy by its mere bulk the proper arrangement of the Book on Ethnography. We shall see presently what is the special interest lying in that study of folklore. But the *music* of the natives might

be considered here, and a serious attempt ought to be made to grasp its strange laws. It will be very soon transformed under white influences, as nothing is more fluid than sound, and its characteristics lost. The study of native music would consist of two parts: a description of their instruments and a trustworthy collection of their songs. We shall speak later on about the best way of preserving those so striking and difficult melodies.

Would it be unwise to add to this part of the book dealing with the arts and crafts, a resumé of the *medical art* of the natives? They possess certainly objective therapeutic means. But as they are intimately connected with superstitions, the common idea is that they all are but charms. Such a view is erroneous. There are a number of real, powerful drugs in the native pharmacopæia, and also a number of therapeutic proceedings which are interesting to observe, and which are the result of a long experience on the part of the "nganga." They must certainly find their place in a complete ethnographical study.

The last part of the book would be entitled: *The religious life and the superstitions.* Here the observer would have to be more careful, more intelligent, more acute than on any other subject. He would have to choose wisely the native informers, but he would be rewarded by an ample harvest of facts and ideas and conceptions, and he would find the native mind swarming with strange, but in a way, reasonable fancies. The ancestrolatry is the best known part of the religion of the Bantu: The notion of the ghosts, the primitive worship which they receive, the dreadful legends which surround their apparitions, the priesthood and the sacrifices, the intimate connection between the worship and the national life of the tribe, all these questions might be treated in relation with ancestrolatry. But the ancestor worship by no means exhausts the religion of the Bantu. There are other sets of intuitions or beliefs which are of a more hidden, confused nature, but in which we certainly find some traces of Monotheism or Pantheism. They are generally connected with the lightning, the fall of the rain, or other cosmic phenomena. It would be highly desirable to have a true account of these religious ideas in every tribe, as their comparison might lead to unexpected and very important discoveries.

Totemism also has left traces more or less easy to recognise amongst the various Bantu tribes. The totem is not worshipped any more in most cases, but it certainly was in former times, and it would be important to note the relations between totem worship and ancestrolatry, and how, eventually, the first evolved into the second.

At any rate, students of Bantu conceptions ought to arrive at a real grasp of their animistic system, and they would in that way get the key to both the religion and the superstitions. Under the heading *superstitions* we would consider those spiritual theories which are not connected with worship, especially the most dreaded *witchcraft*, which has acquired on the Bantu mind a power perhaps unparalleled in any other nation. The *possessions*, that is, the demoniac

explanation of various diseases, are believed in almost everywhere, and would afford a wide field of investigation. *Divination*, with all its various means, is also a wonderful subject, and we should recommend especially the study of the divinatory bones which differ between one tribe and another, but which seem to be used all round according to the same animistic representations. The system, though more or less esoteric, is readily revealed even by heathen divinators, if one knows how to deal with them.

There is a word which exists in most South African tongues, *ila* or *yila*, and means "what is prohibited" or the *Taboo*. A collection of the things which *yila* in each tribe would be most valuable. It would form a kind of book of Leviticus, very complicated indeed, and full of surprises! Some of these prohibitions are quite childish, some of them reveal the presence of astonishing conceptions of nature (for instance, the intimate relation established by the native mind between premature births and the fall of rain!); but, beside the superstitious "yila," an intelligent searcher would soon find a number of moral intuitions much higher than one thinks, and these would no doubt provide us with a connecting point for the more spiritual moral ideas which Christianity tries to instil into their minds.

The question of *moral ideas* is already outside the proper sphere of Ethnography. But it would be best studied here, and I should even attempt, as a conclusion, a description of Bantu psychology. This would be a most delicate but most curious subject. How do the reason, the feelings, the will of the native work? What is the difference between their mind and ours? The difference is wide, we all feel it. But in what does it precisely consist? It requires a good deal of shrewd observation to point it out!

The plan which we have suggested for the book on Ethnography is intended especially for Bantu tribes, which form more than nine-tenths of the South African native population. It would, of course, have to be altered very much if we were dealing with Bushmen or Hottentots.

(2) *The Book on Folklore.*

A full collection of the "Nursery Tales of the Bantu," as Callaway calls them, will be of great value to science, provided they are gathered from all tribes, and in a genuine way, as much as possible in the vernacular, with a faithful translation. Everybody knows about the "Romance of the Hare," which plays in the animal tales of the natives the part of Renard, the Fox, in the European folklore. A complete collection of all the episodes, numbered, and a comparison between the material found amongst the various tribes, would be extremely interesting for the Ethnology of the Bantu. The legends relating to the begnnings of mankind are another important feature of Bantu folklore, and they should be gathered with a view of composing a kind of African Genesis. Moreover, those charming

tales reveal, more than anything else, the mentality of South African races, their moral ideas, and also some obscure, ill-defined notions of metempsychosis which creep into their minds. The Bantu folk-lore offers an immense field of enquiry. Besides the tales, there are any amount of proverbs, enigmas, poetry (especially under the shape of praise of the chiefs by special individuals) most of which might disappear before long. Some of the folklore of the Basuto, of the Zulu, of the Xosa, of the Thonga, of the Loyi and Subiya (Zambesi tribes) has been published, but how scanty is the material at hand compared with the richness of the material which might be gathered!

(3) *The Book on Ethnology.*

Under this title we include all information about the internal history of the tribes, the relations of their clans, their wanderings in historical times, and the more or less legendary stories about their origin, their ancient migrations. Fifty years hence, all these remembrances will have gone for ever; now it is still possible to find old men who have kept the traditions handed down from generation to generation. But the native schoolboys have no inclination whatever to learn what their forefathers did. They crave for English, for white man's knowledge alone, and as very little is done by educational authorities to induce them to keep that treasure, it is bound to get lost very soon. Let, therefore those recollections, and all information about the evolution of the tribes, be gathered at once, and those precious documents will be one of the means by which science will be able to solve the mystery of the origin of the Bantu, and of their development in the past.

(4) *The Linguistic Book.*

Each South African language ought to have its grammar and its vocabulary scientifically and fully published. A good many of such books already exist, and Suto-Pedi-Chwana, Zulu-Xosa, Thonga-Ronga, at least, have been thoroughly studied by linguists, without speaking of the publications of Bleek and others about Bushmen and Hottentot idioms. But we know almost nothing about most of the languages spoken between the Limpopo and Zambesi, the Chopi, Tonga of Inhambane, Ndao, Manyika, Senna, etc. Though the study of the language does not belong to Ethnography proper, those two sciences are by no means indifferent to each other. The classification of the tribes can be based only on the comparison of their grammar; the interesting grammar of Bleek and Torrend shows what great results can be reached by such a comparative study, and, as regards the vocabulary, when one peruses a book like Colenso's Zulu vocabulary, one can see at once how an intelligent explanation of the words introduces the student into the true knowledge of the native mind and habits. Another example: Sir Harry Johnstone,

when he found out that the term designating "the fowl" was the same amongst all the Bantu tribes, came to this wonderful conclusion: The primitive Bantu tongue which was spoken by the natives before it split into all its present dialects, and which must have contained that common word, must have been spoken some time later than the fourth century before the Christian era, because that is the date when the fowls were introduced in Egypt, during the Persian domination. Therefore all the migrations which resulted in the present dispersion of the Bantu were posterior to the year 400 before Christ. This remark, though it is founded on a somewhat narrow basis, shows at least what an immense use Ethnology will be able to make from scientific linguistic monographies.

(5) *The Book on Physical Features of the South Africans.*

"Anthropometric data are everywhere wanting; very few natives have been measured, and the measurements which have been made are insufficient," says Dr. Haddon in his address to the Anthropological Section in Cape Town. The importance of that information is evident to anybody who has some idea of Anthropology, and science wants them as much as any other hitherto described. Of course, there is some difficulty in obtaining from natives their consent to being measured in a way which would be useful to science. But could not the compound managers of Johannesburg and the medical supervisers of the natives working in the mines have all their boys undergo this examination when they are hired? The medical missionaries also might render service in that branch of Anthropology. But these are practical suggestions. Before dealing with them we have still to consider shortly three other theoretical methods by which science will be put in possession of the extensive knowledge which it wants.

B. MUSEUMS.

Our chief South African towns possess museums, and everywhere a place has been reserved for Anthropological collections. Those of Cape Town and Pretoria are worth studying. But, in order to have their full scientific value, ethnographical museums must be more than a gathering of curios. They must be an illustration of the life of the tribes themselves, and not only a collection of the products of their arts and crafts. First of all the origin of each object, implement, piece of clothing, etc., ought always to be indicated. An ethnographical sample without the knowledge of its origin is of no more use than a fossil without the indication of the locality or the geological stratum from which it comes. A separate place ought to be given to each tribe for the sake of comparative study. Secondly, those objects must be genuine, not made for the trade, but found on the spot. Thirdly, an explanation about them ought to be given, and books quoted in reference to them, to enable the student to understand their use and their signification. Take, for instance, the divinatory bones: If you exhibit only the set of 20 to 30

bones of the native divinator, what will the visitor see? Some shells, seeds, nails of beasts, astragalus bones, and that will be useless for him. If, on the contrary, you dispose these strange objects in a definite order, as they might have fallen when a "mungoma" has cast the dice, and explain how they have come to signify such and such a thing, to give such and such an advice, then the student will have learned something worth his visit, and he will be induced to search for more knowledge.

In the same order of ideas, I would suggest exhibiting not only finished implements, but also baskets, arms, costumes, in course of manufacture. Small representations of a village, with its huts, disposed as they are in the veldt, the inhabitants attending to their various occupations, working with their various tools, would be very interesting, and give at once, at a short glance, more comprehension of the Kaffir life than many descriptions in ethnographical books. There is much to be done to make anthropological museums more attractive and more useful for scientific purposes.

C. PHOTOGRAPHS.

The value of photographs of the native life for science is obvious. Nowadays, every scientific work tries to be illustrated, and photography has made that pretension possible. But what kind of photographs ought specially to be taken? When you look to the windows of our South African towns where representations of native life are exposed, you see any amount of stout women, half naked girls, "Kaffir beauties," as they say, which are bought by customers —likely not for their scientific value—as physiological samples of mankind, but from quite different motives. I remember having seen amongst all these more or less esthetic forms a quite different picture: It was the representation of a son-in-law, walking in a Zulu kraal, and happening to come into the proximity of the mother of his wife, sitting down, at the door of the hut; at once the man, who holds an ox-hide shield in his hand, elevates it to the height of his eyes to conceal his face. Who is the artist who was clever enough and fortunate enough to catch that characteristic scene? Such is the kind of photograph which is badly wanted in view of future scientific research! If there were a collection of such pictures taken in the midst of each tribe, how interesting and useful they would be! It is, however, very difficult to get them, and only those who have an intimate knowledge of the natives, and who have won their confidence, will be able to obtain such precious material.

Why do not painters pay more attention to picturesque native life, in the midst of the splendid South African scenery? We see hundreds of pictures of Arabian tents on the border of the Sahara, and almost nothing of the Bantu kraals! It even seems as if Fine Art did not consider them worth being represented at all, except in caricaturing them! These caricatures of a hideous negro, with red lips and a stupid smile, are found everywhere. Science might expect something better from painters of this generation!

D. THE PHONOGRAPH.

As we already stated, the native music is exceedingly difficult to reduce to writing. Why is that? Because the primitive Bantu has not a clear, defined idea of the scale, major and minor; his half tones are not the same as ours; his harmony proceeds by fourths rather than by thirds or fifths, as does ours; to a European, it is almost impossible to reproduce the sounds of that music. But then we have the phonograph, which is to the world of sounds what photography is to the world of images: a faithful, unprejudiced witness. A score of such records, preserving the most characteristic war songs and other musical themes of each tribe, would be an invaluable addition to our knowledge of the Bantu music.

PART II.—PRACTICAL METHODS.

So far, we have considered the work which ought to be done to satisfy the legitimate desire for knowledge on the part of science. It is enormous. Hundreds of books, immense collections of objects difficult to obtain, of photographs not easy to take, ought to be put at the disposal of Anthropology. That means hours, years, of time consecrated to study, great sums of money expended, and, above all, a score of energetic and enthusiastic men to bring to a successful issue such an undertaking. In our busy commercial and agricultural South Africa, where theoretical scientific researches without practical value are not held in great esteem, it would be foolish to expect that the plan sketched in the preceding pages will be realised fully. But there is, perhaps, more devotion to science amongst us than we are disposed to concede, after all, and the success of the meeting of the B.A.A.S., and the interest evoked by them all over the country, make us hope for better times. Let us therefore turn our attention to the practical side of our subject, and propose some suggestions in order to realise what is actually practicable.

If that immense amount of information is to be gathered and put into a form available for scientific research, it can be done only by the co-operation of two different agencies: those who are to collect the materials, and those who are to work them out.

The Collectors.—It is quite obvious that only people thoroughly familiar with the language of the natives and staying amongst them can provide the needful anthropological information. This double condition excludes most of the merchants who deal with natives; they are settled amongst them, but are generally satisfied with speaking "Kitchen Kaffir," that horrible deformation of the Bantu language which is just sufficient to give orders to servants, sell calico or buy mealies, but which will never introduce a white man into the true mentality of a native! The travellers also, cannot, as a rule, be trusted with a thorough anthropological investigation. Not only do they not know the language, but they cannot stop long enough amongst the kraals to study the native life. However, some travellers have rendered great services to science, because they were men with open

eyes, with scientific culture. The traveller is the best investigator in the first phase of Anthropological study. What he can do now in South Africa is to reveal to people on the spot what is worth observing and how to observe.

Three categories of individuals remain who can gather the needed information: The Native Commissioners, the missionaries and the educated natives.

The Native Commissioners know, or are generally supposed to know, one or two of the vernacular languages. They have the opportunity of studying the natives, at least their "indaba," not all of them (as the petty civil offences are generally left to the chief to judge), but the most important of them. They are therefore in a position of learning a lot, and can provide precious information regarding the laws of the native tribunal. Some of them are men of learning and have wonderfully understood the Bantu mentality. It is sufficient to mention the names of Somtseu (Shepstone) and the charming stories of Scurvy.

But *the missionaries* can do and have done much more than the Government officials. Their calling itself induces them to study the customs, ideas, and beliefs of the heathen, and, as they are generally in the very midst of them, in the proximity of the capital, they see and hear more of them than any other class of people. Most of the information published so far has been gathered by them. It is true that many of them, in their professional zeal to destroy wrong ideas of heathenism, are apt to despise them altogether, and to reject at once as diabolical invention every manifestation of the savage life, without that sympathy which seeks and finds in primitive beliefs and superstitions some diffused rays of truth, some λόγος σπερματικὸς of aspirations to a higher life. But now many of them have abandoned the old conception, and even if they do not find much spirituality in the heathen system, they are aware that it must be studied, because Kaffir Christianity will be greatly influenced by the previous beliefs and by the former character of the new converts. Let them be encouraged and guided in that study, and the result will be great.

Educated natives would also form a first rate source of information "a priori" speaking. They know better the Bantu mentality than any white man, being Bantu themselves. But unhappily, in most cases, the more they get educated, the less interest they find in their old ideas. Moreover, just as an historian cannot easily write contemporary history because he is too near the events to appreciate them properly, a native still amongst his savage surroundings is not able to describe in a comprehensive way the national life of his tribe. Let us add, however, that he would be less accessible to preconceived ideas and prejudices than a white man, who is always apt to introduce foreign conceptions in his descriptions. The interesting book of Azaria Sesheke about the habits and customs of the Suto, partly translated by the Rev. Jacottet in the *Bulletin de la Société de Géographie of Neuchâtel*, shows

that a lot of precious material might in the course of time come from that source.

But suppose a Native Commissioner, or a missionary, struck by the amount of unrecorded and picturesque material at his reach, beginning to put questions to intelligent natives, to understand the reason of their strange habits: he feels in himself the desire to gather all that information, notwithstanding the pressure of his daily work; he writes what he has observed: he does not know what use he will make of his notes; he simply obeys an internal call, that desire of knowing and of making known, which is the basis of every scientific inquiry: but nobody offers his help to put those precious materials at the disposal of Anthropology. All his trouble will be in vain, and science will for ever be ignorant of his work. Callaway, the author of the two classical books on the Zulu, had written other manuscripts. He could not afford to publish them at his own expense and they are lost! Still later, a German missionary amongst the Ba-Venda, Rev. Beuster, wrote very interesting notes about the tribe in which he laboured for more than 30 years. He died, and all those materials, which he alone could have put into proper form, remained useless! If he had been encouraged we might have now a full description of that highly characteristic branch of the Suto tribe. What is wanted is a central agency which would receive the material collected by people on the spot and publish them in a way which would make them available for science at large.

The Investigating Commission.—There ought to be created without delay a *South African Anthropological Commission*, which would answer to the need just pointed out. The elements to compose it would not be so difficult to find. The Committee of the Anthropological Section of the S.A.A.A.S., which worked in the various towns of South Africa, especially in Cape Town and in Johannesburg, might form the nucleus of it. Cape Town, with its University, with its splendid Museum, with the work already accomplished by men like Dr. Bleek and Dr. Theal, with its Philosophical Society, is already a scientific centre, and might take the lead. I am not aware of the existence of much interest for Anthropology in Natal, but there ought to be at least some people disposed to collaborate in the work in that Colony. With its dense native population, it must be aware of the importance of all questions connected with aborigines. In the Transvaal, Johannesburg is in a way an immense native town, and there are hundreds of white men who know the vernacular amongst them, and there are sure to be some who would be in sympathy with such a Commission. I would suggest two other elements to introduce into it; the members of the Inter-Colonial Native Affairs Commission, who have done such splendid work during past years; the evidence which they took, the knowledge which they acquired, was essentially meant for practical purposes, and they might be disposed to continue their study for the benefit of science: (2) another important element would be the staff of the future Inter-State Native College, which is about to be founded. It is the intention of the promoters of that scheme

to include in the programme a chair of Bantu Anthropology, and that institution ought to become a centre for scientific study of native Ethnography and languages. It is difficult for us living far from towns to frame more definitely the composition or the nature of that Commission of Anthropology. Should there be only one Commission, or would it be advisable to create separate committees in the various centres ? We leave the question open, but about the task which it would have to fulfil there is much to say.

In view of the general inquiry which is to be undertaken, the Anthropological Commission should :—

1. Compile a complete list of the works which have been published up to date on South African Ethnology. Dr. Haddon concluded his address by a short bibliography of books on the subject : as he confesses, it is manifestly very incomplete. It does not mention linguistic books, and ignores a number of valuable works (for instance, the writings of Jacottet on the folklore of the Ba-Suto and of the Zambesi tribes). Moreover, a collection of these books ought to be made and put at the disposal of future students, and this would prove a difficult though very useful preliminary step.

2. Encourage students of Bantu or Bushmen or Hottentot Anthropology to write their observations, as fully, scientifically, and as early as possible, with a view of sending them to the President of the Commission. That might be done in many ways : one or several yearly prizes ought to be offered for the best monograph on a South African tribe, whether on its ethnography, its ethnology or its language. Another prize might be conferred on the author of the best series of photographs having an ethnographical value and accompanied by an explanatory text. The prize offered must be tempting enough to induce people to undertarke such a work. Though such memoirs will be written, not for the sake of winning a prize, but because the observer feels himself constrained by what I termed an internal call, yet a reward for the work done might do much to encourage the investigator.

If any elaborate work is composed in answer to that call, the Commission ought to be ready to publish it, if it is found to be of true scientific value.

3. But that would not be sufficient ; the missionaries, Native Commissioners, might not have time nor perhaps the ability to gather all the materials for an encyclopedic study. Therfore I would suggest to the Commission to start a South African Review of Anthropology. This new periodical might publish such extensive works if they are contributed. But it would be provided with another and more regular supply of material. The Commission would prepare a "set of questions" on Anthropology, following, for instance, the plan which I proposed for the book on Ethnology. Those questions ought to be sent to the various missionary bodies working in South Africa, and to the Native Affairs Departments, asking them to select from their staff one or two men who would be in a position to answer them. In that way information would be got from every quarter. As regards

missionary societies only, the Commission of Anthropology might approach:

For the Zulu: The American Zulu Mission, the Dutch Reformed Church, the United Free Church Mission, and the Scandinavian and Norwegian Missions.
For the Xosa-Kaffir: The Moravian and Scottish Missions.
For the Matabele: The London Mission Society.
For the Swazi: The South Africa General Mission.
For the Suto: The Paris Evangelical Mission.
For the Chwana: The London Missionary Society and the Hermansburg Mission.
For the Pedi and the Venda: The Berlin Missionary Society.
For the Thonga-Ronga: The Swiss Mission.
For the Chopi: The Mission of the Bishop of Lebombo.
For the Tonga of Inhambane and the Mashona: The Methodist Episcopal and Free Methodists of America.
For the Ndjao of Gazaland: The American Mission of Mount Selinda.
For the Ovampo and the Namaqua: The Rhenish and Finnish Missions, etc.

The individual Wesleyan and Anglican and Roman Catholic missionaries who are spread amongst the many tribes might also be approached.

The questions to be inquired into might be distributed over ten years, for instance, and each quarter, answers on a certain number of them would appear, in full or in *resumé*, in the South African Review of Anthropology. Should this plan be followed, there would be soon an enormous quantity of material gathered. Special attention would be paid to tribes still unknown or little known, as the Chopi, the Ndjao, the Manyike, etc. Though the *raison d'être* of the Review would be the publication of this purely scientific information, it would be useful to open wide our periodical to any correspondence about native questions. We dearly want, in South Africa, a paper dealing authoritatively with all the aspects of that difficult, vexing, infinitely important question. The scope and the interest of the Review would be greatly increased if it were to accept impartially any sincere expression of opinion on native policy, native rights, etc. And the circle of readers would be greatly enlarged should the Review show a true grasp of the question.

4. The preceding suggestions apply especially to Bantu Anthropology. But we have in South Africa another race which is very nearly extinguished, and for which other provisions ought to be made, namely the Bushmen. A lot is known about them, owing to the studies of Bleek, and of Mrs. Lloyd. But how strange it is that a great part of that valuable material, gathered by scientists of such prominence, should still remain unpublished and lie almost useless in the "Grey Library" in Cape Town! Our Commission ought to have all those manuscripts printed, even if it were only in honour of that man whom Dr. Haddon calls fitly a

"devoted scholar." But according to the same writer there seems to be another race, different from the Bushmen, in this wonderful South Africa, which might be the most primitive race of all mankind, and which was never properly studied. They are called Kattea, and live in the north of the Transvaal, at three or four days' distance from Pietersburg, from the railway. Dr. Haddon hopes that a serious effort will be made to investigate them. It would be the task of our Anthropological Commission. I would suggest that it should appoint a travelling agent to go to the spot and get all the knowledge possible about these interesting people. The man who would be trusted with such a task, ought, of course, to possess a great measure of tact, wisdom and ability, and could be greatly helped by one or two educated natives. What an immense interest the narration of his travels would give to the Review !

Having described, in its main features, what the activity of the Commission of South African Anthropology should be, and coming closer and closer to the practical side of the question, I should add two suggestions about the means of making all that machinery work properly.

The great difficulty would be to find the man who would be Secretary of the Commission, the living personality who would link together all those various agencies. A learned, scientific man, he must be, to give to the Review its lustre and assure its success. He ought to know his South Africa well, as well the native as the white South Africa. On the other hand, he must be in sympathy with the black, because, as Sir Richard Temple says (quoted by Dr. Haddon) "sympathy is one of the chief factors of successful dealings of any kind with human beings." And more than everything else, he must be an enthusiast, understanding the immense importance of the investigations over which he would preside, and not fearing to be somewhat troublesome to those people on the spot who would gather for him the information wanted and who might be sometimes a little too lazy. Is such a man living ? If so, would he consent to undertake such a task? I have spoken about the future Native College as having to become a centre of Bantu study. Would our Secretary be found amongst its future staff? At least, could not this great work of scientific inquiry be connected in some way with that institution?

But such a man, such a Review, such a mighty work, would cost much. And here, as everywhere, the sad, deplorable question of funds arises. Where ought they to come from ? From individuals, first of all. There are wealthy men in South Africa. Many have been enriched owing to the collaboration of native labour. Would not some of them make a gift, a substantial gift, to reach the aim? It would be for science; science is worth sacrifice. But our South African States ought also to contribute regularly to the execution of the scheme. The Transvaal revenue derives more than £400,000 from the natives. A generous native policy would decide, as a question of honour, that all the money got from the aborigines should go back to them or be spent in their interest. Such is not the case;

far from it, I am afraid. Could not the States put yearly a couple of thousand pounds at the disposal of the Commission for South African Anthropology?

In conclusion, my last suggestion is this: Should this and other essays have convinced their readers of the necessity of undertaking without delay a general and full inquiry in the Ethnography of South Africans, the Committee of the Anthropological Section of S.A.A.A.S. ought to take three steps: (1) To approach those persons who would be fit to form the Commission for South African Anthropology and ask for their collaboration; (2) To address a circular letter to the missionary conferences, to the Native Affairs Departments, describing the scheme, and asking if missionaries, Native Commissioners, and others, would be willing to assist in getting material; (3) Then, if the answers are of an encouraging character, the Committee, or, eventually, the new Commission for South African Anthropology, could make its scheme public, and ask financial aid from private individuals and from the Governments.

"What judgment will posterity pass upon us, if, while we have the opportunity, we do not do our best to save the memory of these primitive folks from oblivion?" asks Dr. Haddon, at the conclusion of his address. The judgment of posterity upon us will be extremely flattering if everybody does his duty as I have tried to describe it here. Only, in this imperfect world of ours, it is so rare to see everybody doing his duty!

3—AN ETHNOGRAPHIC BUREAU FOR SOUTH AFRICA.

By Dr. H. Lyster Jameson.

Systematic investigations of the native races of British South Africa from the Anthropological and Ethnological standpoint, must be undertaken without delay, if we are to acquire anything like an extensive knowledge of these peoples. Of the three aboriginal races which were in possession of the continent at the time of the first European settlement, two are fast disappearing. The Bushmen have been reduced to the verge of extinction by the hunts or massacres organised by the early pioneers. The Hottentots (with the exception of a few thousand Namas in Namaqualand who are still comparatively pure blooded, and who still speak the Hottentot language) are now mostly hybridised with Europeans, or other native races, and speak a degenerate Dutch "Taal," which has entirely replaced their original tongue. The third race, the Bantus, the predominant element in the native population of South Africa, has always been a very adaptable people, so far as we can judge from their scanty history. These Bantus are now adapting themselves so quickly to European dress, customs and religion, that, in another generation or two, if we can judge by the course of events in the last quarter of a century, the material for their study will be almost as scanty as that afforded by the Bushmen. The fourth South African race, the "Kattea," or "Vaalpens," of the North-Eastern Transvaal, which may prove to be the nearest of all living races to the original stock from which the several families of mankind are descended, will unquestionably share the fate of all primitive peoples, extinction or absorption, as soon as civilisation spreads northward.

If the Ethnographical Survey of British South Africa is not undertaken at once, it will find itself resolved in great measure into an archæological survey.

So far comparatively little has been done in the field of South African Ethnology. The really first-hand and original literature of South African anthropology may be mastered, if we except languages and philology, by the perusal of some hundred odd anthropological works and books of travel. For these works we have almost entirely to thank private enterprise, if we except a few investigations conducted under the auspices of museums and scientific societies, and still fewer under direct Government patronage. The most familiar of the latter are the reports of the several Native Affairs Commissions, whose enquiries have been undertaken for political rather than for ethnological purposes, and whose results are, from the standpoint of the scientific man, hardly more satisfactory than the disconnected observations of the book-making traveller.

The most comprehensive observations on native ethnology have, as might be expected, been made by enlightened missionaries and sympathetic magistrates and officials, and by a few professional or amateur ethnologists who have devoted longer or shorter periods to South Africa. But little more than the surface soil has been turned so far, and there are strata upon strata of material awaiting even discovery. There must be a vast amount of information on native customs

in the hands of magistrates, traders, farmers, missionaries, and others who have not the inclination nor the literary skill to put it on record in writing, and who lack the ethnological knowledge necessary for sorting and arranging their material. Much of this information is in the hands of old Colonists, gleaned from natives who have died long since. It will be lost to posterity on the death of these Colonists. In the early days, when an intimate knowledge of native customs and etiquette was more necessary to the white man that it is to-day, many of these pioneers obtained information that could with difficulty be elicited now. It is a matter of urgency that treasure houses of ethnic data such as these should be unlocked by the trained ethnologist before it is too late.

And year by year the old generation of natives is dying off. The old men who hold the key to many an ethnic problem, men whose very traditions may in great part die with them, are being replaced rapidly by the modern, half-civilised, half-educated product who, while interesting us sociologically as a chapter in the evolution of a new type, is of very little use as a source of native traditions and folklore or as an authority on native customs Whole pages of the book of African ethnology are being lost every year, and will have to be imperfectly reconstructed from the context.

There is only one kind of organisation, in the opinion of the present writer, that could hope to cope with the volume of work that lies before the ethnologist in South Africa. That is a South African Bureau of Ethnology, which should be a federal if not an Imperial institution. The writer holds that the ethnology of South Africa must be worked as a whole, if an unnecessary multiplication of experts is to be avoided. In such a field as the study of the native races of South Africa, where the greatest amount of work must be done for a given endowment in the least time possible, a federal or South African Bureau must have great advantages over a Colonial or provincial one. Moreover, the native question is such a prominent one in South African politics that a bureau financially dependent on a purely local Parliament would run a certain amount of risk of subordination to political ends—which would be fatal to honest work. For the above reasons the writer thinks the bureau should be a South African or inter-Colonial affair.

Before indicating the broad lines on which such a Bureau would work, it will not be out of place to make some reference to what has been done in other countries.

In India there is an ethnological department. There is an officer for the whole of India, and there are officers for the several Provinces. All these appointments are honorary, but they are worked by Government, and have paid staffs of ethnologists.* In Australia† all matters relating to the aborigines are left to

* For this information I am indebted to Mr. George A. Grierson, C.I.E., of the Linguistic Survey of India.

† Information kindly supplied by Mr. Charles Hedley, of the Australian Museum, Sydney.

the various States, the Federal Government taking no part in these questions. In Tasmania, New South Wales and Victoria, it is already too late to do anything, the only Colonies where the aborigines exist in any numbers being Western Australia, the Northern Territory and Queensland. In Western Australia and the Northern Territories little notice is officially taken, but in Queensland, during the past ten years, Dr. W. E. Roth, Protector of Aborigines, has written a series of bulletins minutely describing native manners, customs and implements, which have been published by the Queensland Government. In New Zealand a great deal of work has been done, largely through the Colonial Museum at Wellington, the director of which, Mr. A. Hamilton, has made a special study of native art. The ethnological survey of the United States is in the hands of the United States Bureau of Ethnology of Washington, which has a staff of professional ethnographers. Hitherto this bureau has confined itself to investigating the aborigines of the United States, but recently it has been authorised to conduct the researches in Hawaii as well. "The Philippine Government, which is semi-independent, organised a Bureau of Ethnology of its own, and some very good work has been done; but this bureau is now merged, I believe, in the Department of Education, and is probably not being conducted with sufficient energy to give us results commensurate with the great field of research furnished by the various peoples of the Philippines."* Germany has an Imperial Bureau, and regards the scientific investigation of her Colonial aborigines as one of the responsibilities of colonisation, and the same applies to Holland.

The functions of a Bureau of Ethnology such as I advocate for South Africa would be mainly twofold. The first and most obvious duty would be to conduct an ethnological survey of South Africa. This would entail a staff of field ethnologists and a central bureau presided over by an ethnologist of the highest standing, to co-ordinate and direct the field work. The second great duty of such a department would be to provide a training in South African ethnology, not only for young men who aimed at qualifying as field ethnologists in the service of the bureau, but also for cadets for those branches of the Government service (Native Affairs Departments, court interpreters, native magistrates, inspectors of native schools, etc.) in which a knowledge of the inner significance of native customs is the necessary foundation for broad-minded and sympathetic administration. To combine both these ends the bureau should be in close association with one of the museums, and with one of the great colleges, through which in the near future all Colonial born candidates for posts of responsibility in South Africa will have to pass. The bureau would then control the ethnological and anthropological branch of the museum, and a department of the College or University, the department of ethnology, through which young Colonials whose future careers would bring them into close touch with native affairs would

* For the above information I have to thank Dr. R. Swanton, Ethnologist of the U.S. Bureau.

have to pass, and in which they would learn to look upon the native, whom they would later be called upon to rule, in a new light. The present writer is strongly of the opinion that by providing such a training for our future native officials we can do much to lessen the risks of injustice and oppression that are inevitable in a country where a majority who have not, and cannot have the franchise, are governed by a small minority of voters whose prosperity depends upon the others' labour.

Three centres suggests themselves for the headquarters of such a Federal Bureau. The first is Cape Town, with its South African Museum, already famed for its Ethnological Department, which owes much to the energy of Mr. Peringuey and to the South African College, which, nobody who has followed the trend of educational movements in Europe and America can doubt, is destined to become one of the Empire's great centres of University education and research. The second centre that fulfils the necessary conditions is Grahamstown, where we have the Albany Museum and the Rhodes University College, working hand in hand for the advancement of learning in South Africa. The third place that would seem to be a suitable headquarters for the bureau is the proposed University of the Transvaal at Frankenwald, for the establishment of which the late Mr. Alfred Beit has made such noble provision. Unless the jealousy of vested interests stifles this great ideal, the Transvaal has the opportunity to establish a teaching University that in many ways will be without a parallel in the world. Such a University would be a fitting home, if for no other reason on account of its geographical position, for the central offices of the South African Ethnographical Survey.

I offer no plea for the establishment of the bureau at any one of these places. The great thing is to get the bureau constituted as quickly as possible, and its *locale* can be decided later on.

The work of the bureau should be under the control of trained ethnologists, who should have the assistance of educated and specially trained men of local experience, young Colonial-born men who speak the language of the native races, and understand them from long contact with them. To be of real service these men must be trained systematically in the theoretical aspect of their work, and a great part of this training can only be given at a University, in the form of connected lectures by an ethnologist. And at the University the young men would gain, in addition to a training in their special subject, a knowledge of the collateral subjects, such as Biology, Psychology, and Comparative Philology.

The chief of the Bureau would have to be an ethnologist of the highest standing, since on his knowledge, and in an equal degree on his personality (a condition too often overlooked in the filling of scientific posts in the Colonies by men chosen from Home) the success

of the bureau would in great measure depend. Under him should be a staff of field ethnologists, the number of whom would, of course, be determined by financial considerations. Probably a good start could be made with two senior and two or four junior men. The former should be men with some field experience, the latter could probably be chosen from among the young graduates of our Colonial colleges. The knowledge of native languages and customs which these men would possess would greatly facilitate the field work of the bureau, while, for taking down traditions and folklore in the native tongue, as practised by the American Bureau, their services would be invaluable. After a time each of these men could be placed in charge of a whole ethnographic division of the country, including the conservations of its prehistoric remains, such as Bushman drawings, etc. From time to time it would be efficient to increase the department's staff, and this could be done entirely by drafting the best students from the college on graduation, as, given a thoroughly good ethnographical school, the Colonial born man would be infinitely more efficient than the young graduate imported from the schools of Europe and America, thoroughly ignorant of the native languages, and of the conditions of life in South Africa. It is easy to suggest many ways in which, by judicious division of labour, the work of our bureau could be rendered more and more efficient, such as the allotment of special subjects to individuals, one being told off to visit some surviving outlier of the Bushman race, another specialising in native music, another perhaps, making a study of the Vaalpens, and so forth. Details of this kind are, however, beyond the scope of this paper.

The department would, in addition to conducting actual researches, keep in close touch with missionaries, magistrates and others who were able to make observations and collect information, and when the returns of these amateurs contained matter requiring investigation by an expert, a district ethnologist would go down and study the matter personally. An immense amount of work could be done in this way, the bureau co-ordinating and directing the work of volunteers. The amount of work that has already been done by amateurs is ample proof that there would be many willing to forward the work of a bureau. In many cases it would even be found practicable to place a set of anthropometric instruments at the disposal of a mission station, police camp or native school, and to send a field ethnologist down for a week or so to give instructions in the use of these, and in the recording of measurements. More work could be achieved by one ethnologist who was in close and friendly touch with the amateurs in his district than by half-a-dozen men working on their own account, and out of touch with the local students of native life.

It may also be pointed out that the bureau would probably receive some assistance from time to time through the visits of specialists from Europe and America, men collecting information on native art, folklore, etc., and anxious to obtain first-hand information concerning the peoples about whom they write, aided, perhaps, by grants

from learned societies or by research studentships. Such visitors would be all the more likely to come if they knew there was a local bureau that could put them in touch with all the best sources of information in their special subjects, and in return the bureau would benefit greatly by their advice and opinions.

The central Ethnological Museum, situated at the headquarters of the department, would have a prior claim on all ethnological objects of national interest, collected by the officers of the bureau. It might be possible to defray some of the expenses of the bureau by the sale to other museums of duplicates, though in view of the fact that the serious study of South African ethnology (like that of South African Natural History generally) will have to be done in South Africa, and not by chamber scientists at Home,* great care should be taken to prevent the too lavish exportation of specimens. It is interesting to note in this connection that the export of native curios from New Zealand is now prohibited by law.

The next question is: what would be the scope of the investigations of such a bureau, and what would be gained by its work?

The branches of ethnology and anthropology in which in the opinion of the present writer there are the most crying needs for investigation, are: (1) The study of traditions, folklore, beliefs and customs; (2) Experimental psychology, and mental growth statistics; (3) Physical observations; (4) Study of the mixed races.

It is difficult to see how full details of traditions, folklore, etc., and particularly of the variations of the different traditions in different tribes, can ever be compiled without a central bureau to tabulate data and to indicate lines for further study. No amount of scattered writings and haphazard observations will ever furnish a full insight into the psychology of the Bantu. Obviously our bureau, whose officers would have the literature of their subject at their finger ends, could, by circulating instructions and question sheets among volunteers, obtain not only casual notes, but co-ordinated records. In this way it would be practicable to take certain subjects of special importance or urgency and to press forward the investigations of these first, till sufficient material was collected to monograph a particular branch, say marriage customs, animism, or some other matter. A monograph of this kind would be of extraordinary value, compared to the usual ethnographic writings, because based on investigations on the same lines made simultaneously at various centres. There can be no question that an insight, such as these records would give us, into questions like marriage customs, or the tribal legal procedure (formerly very complex among the Bantus in their own administration of justice) would have an important practical bearing on the administration of native law.

Thanks to the work of Dr. Bleek, we have a copious Bushman's folklore in the form of eighty-four manuscript volumes available for future reference in the Grey Library at Cape Town, together with an incomplete Bushman Dictionary. The time is fast coming when we will have to approach these records as the papyri of Egypt were

approached, for the services of Bushmen capable of explaining and interpreting would even now be difficult to obtain. The investigation of these manuscripts, with the practical study of the Bushmen that should accompany the work, would naturally fall within the province of the bureau of ethnology.

In dealing with the remnants of the Hottentots, the bureau would naturally co-operate with the German department.

The psychology of the native races, from the experimental aspect, is almost a sealed book. There is scope for much work, under direction, a great part of which could be carried on at mission stations, native schools, etc. The study of the mental development of the native child, correlated with the study of its physical growth, would probably help us better than anything else to assign to the Bantu his proper place in society. It has been proved in the case of the northern division of the negro race (the Soudanese) that the sutures of the skull close earlier in life than they do in the European, thus early arresting brain growth and mental development. The result of this is obvious on comparing the mental progress, say, at school, of the negro child and the European child. The negro child, in his earlier years, does not compare very unfavourably with the European, but about puberty his mental development is arrested, and he becomes stupid, just at the period when the brain of the young European is most receptive. This fact is familiarly expressed by the Colonist when he says " the native is a child, and must be treated as such."

Observations based on correlated periodic statistics of school progress and cranial growth over a large number of native children are particularly desirable, especially among the Bantu and Hybrid Hottentot peoples, for by the results of such observations, better than by general experience, we will be able to determine, with some measure of probability, to what extent it is desirable to raise the several aboriginal races towards the status of the European.

With regard to anthropometric data, we have really appallingly few measurements of the South African races. While our bureau could, through its officers, compile a lot of useful statistics, it could do still more by encouraging this work among amateurs, and by training them in the use of the instruments. The lack of information, not only on dimensions, but on such points as eye-colour, skin-colour, hair, shape of the ears, nose, and other features, is quite surprising, when one comes to hunt up data on the aborigines of South Africa. Similarly we know next to nothing about native psychology, growth, teeth sequence, stature at time of birth, reproduction statistics, and so forth.

I can only touch on linguistics. Although languages are, from the purely ethnological standpoint, about the least important field, the bureau could be of great service in co-ordinating the work of the many observers in this line.

Not the least important, from both the anthropological and the political standpoints, of the provinces in which our bureau would work, is the study of the mixed races, such as the Griquas, races

collectively spoken of as "coloured people." It is probably only by the unbiassed statistics of the ethnographer, based on careful and unprejudiced study of these races according to anthropological standards, that their real merits and demerits will be understood, and that we will be able to assign to them the sphere in the community that they are best fitted to fill. There are already two versions of the "half-caste" case. The popular idea, as expounded by the "mean white" all over the world, is that the mixed races combine all the worst qualities of both parent stocks. On the other hand, there are not wanting statements to the contrary. We have the opinion of a distinguished ethnologist (Dr. Robert Dunn) in "The Unity of the Human Species" (1861), that half-castes very generally combine the best attributes of the two races from which they originate. A means could probably be devised to test both these views by applying some of the methods which have been employed in Europe to elucidate the effects of cross-breeding in animals.

South Africa spends many thousands a year on scientific investigations which have a bearing on the problems of agricultural development. We maintain Geological Surveys and Marine Biological Departments to advise us as to the development of our mineral resources and our fisheries. We claim to be an eminently practical people.

But ask any man in the street "what is the great problem of South Africa?" Nine out of ten will answer, not agriculture, not the future of the mineral industry, or any other industry, but "the native question." And yet that is the one problem to the elucidation of which we have not yet applied the resources of natural science!

A Federal Bureau of Ethnology would not necessarily require a larger staff than that which I have indicated. It would cost less by far than one department of agriculture, and not much more than a Colonial Geological Survey. The contribution from each Colony would be an insignificant sum, the abstract gain to science, and the practical gain to the white people of South Africa would be enormous.

If I have appeared to unduly emphasise the practical and political value of a bureau of ethnology, it is because I cannot help thinking that had this aspect of the case been thoroughly realised, such a bureau would already be in existence at the present day.

4.—OUR PLACE IN HISTORY.

By C. D. Hope, M.A.

Introduction.

What course of South African history will satisfy the intelligence of senior pupils, deepen their understanding of South African affairs, and lead them on to a more general interest in the progress of mankind? The answer is that we must cease to interpret South African history as the mere record of events within this country itself. These events must be known and appreciated; but, taken by themselves, they will never be thoroughly understood.

If we desire to understand South African history we must apply the comparative method, we must examine events in connection with the forces which produced them, we must abandon the task of chroniclers, and make an effort to realise our place in general history.

Many events in South African history are merely the counterpart of precisely similar occurrences in other new lands peopled by European settlers. Other events, however, are emphatically peculiar to this country alone. In neither case can a just understanding be obtained when the comparative method is neglected; and yet no consistent attempt has hitherto been made to treat our history otherwise than as the self-contained record of an isolated collection of human beings.

In 1902 it was the privilege of the present writer to draw the attention of the University Council of the Cape of Good Hope to this most serious question; the matter was taken up by the Hon. J. X. Merriman, and a Committee issued a syllabus of comparative studies in Colonial history for the B.A. degree, which came into force for the first time in 1906. The existence of this excellent syllabus must in itself break down the baneful barriers which have hitherto surrounded historical work in South Africa, and the following pages are merely an anticipation of the methods which must in future prevail.

South African history opens with the great burst of enterprise by which the white races re-asserted the position that they had won in the days of Alexander the Great and of the Romans. In affairs of intellect this movement is spoken of as the Renaissance; and as literature and art, like Narcissus of old, have ever been too much delighted with the reflection of their own charms, writers have allowed themselves to speak of this period as if nothing better had been produced than some paintings in Florence or some sculptures in Rome.

In realty this period saw the delivery of the white race, on whom all progress depends, from actual bondage and ever present fear of the brown and yellow men of Africa and Asia. When Spain lay under the rule of the merciless Moor, when Tartar horsemen possessed themselves of the Steppes of Russia and threatened Germany from the East, when the Turk conquered the Capital of the first Christian Emperor, overran the Balkan Peninsula, invaded

Southern Italy, and thundered at the gates of Vienna, where at that time was the boasted strength of the white man? What was the aristocrat of the human race but a cowering and unwarlike inferior fighting in desperation to save central Europe from the conquering hordes of Asia and of Africa?

The salvation of Europe lay in maritime enterprise. The life-work of Henry the Navigator was consciously directed to the overthrow of Mohametan power. Portugal being freed from her Moorish lords, Prince Henry had seen the futility of campaigns in the rugged fastnesses of the Atlas mountains. The strength of Islam lay not merely in religious fervour or military prowess, but still more in the wealth which the Turks and Arabs obtained by taking toll of all trade between Asia and Europe. To attack this power he resolved to circumnavigate Africa and take the foes of Christendom in the rear. Long years of toil, of study and of disappointment were needed to achieve even the first steps on this arduous road. When the Prince died he had made a beginning of the great work which was to make his name immortal. He had recovered the lost knowledge of Greek geographers, he had sent his ships to the Canaries and to the Gambia River; but, above all, he had trained crews and captains to the work of ocean navigation. The next half century saw the work of Christopher Columbus and of Vasco de Gama, and it is hard to decide which of these men did the greater work in securing to the white man the lordship of the earth. The gift of the splendid continents of America gave to Europeans a new and unassailable future, while the mastery of the Indian Ocean sapped the prosperity of Islam and opened to white merchants the markets of half the human race.

South Africa is intimately concerned with the period in which Almeida and Albuquerque planted their stations at the strategic points of the Indian Ocean, and forbade any ship to sail its waters without their licence. Africa was the obstacle overcome by the explorers; Asia was their prize, and from Asia, the African coast was administered. Thus Mozambique received its orders from the Governor at Goa, as did Cape Town afterwards from Java.

This lordship of the ocean was the distinguishing work of the 16th century. To Portugal belonged the whole Indian Ocean, and to Spain the Pacific, while the arbitration of Pope Alexander divided the Atlantic between the two southern powers. On his accession to the Portuguese throne, Philip II. became the Emperor of all the oceans, and none but his subjects might sail them. We all know that Britannia rules the waves, but in her wildest flights of fancy she has never desired to annex all the salt water. Her trident has been but the policeman's truncheon of the deep, expelling pirates and evil-doers and keeping the highway clear for all nations. Beyond the three mile limit no country now claims any lordship of the sea.

It was not to be expected that the northern nations would long acquiesce in the extravagant claims of Spain and Portugal. Nor did they do so when another generation had grown up, familiar with

oceanic navigation. The Devonians and Bretons, whose fishing fleets sailed yearly to Newfoundland and Iceland, and the harpooners of Zeeland, who hunted whales in the Arctic, felt themselves the equals of the southern mariners who claimed all the lucrative trade; and it is probable that, apart from religious convulsions, there would soon have been a contest for freedom of navigation. At this very time Europe was rent in twain by the Reformation, North was arrayed against South in a struggle of life and death; and, in the mighty drama of religious wars, there is danger of looking upon the work of the navigators as a mere episode. For Philip II. threatened to dominate Western Europe with mighty fleets and veteran armies, and against him were arrayed England, Holland and the Huguenots of France. It is by no mere accident that South Africa is peopled by English, Dutch and Huguenot French; for the ancestors of these men resisted the tyranny and defied the pretensions of Spain, opening the highway of the seas and seizing the newly-discovered lands for the nations of Northern Europe.

With the Seventeenth Century we reach the culminating point of Dutch prosperity; and we find ourselves in the age of great companies, both Dutch and English. Both of these circumstances must be understood to explain the voyage of Van Riebeek. Why was he sent out by a company? Because all the enterprise of Holland and England was at that time the work of companies. Why was the company Dutch and not English? Because the English followed mainly in the path of Spain and turned their chief attention to the Atlantic coast of America, while the Dutch were the successors to the Portuguese, whose commerce they had destroyed, and their policy virtually treated the Indian Ocean as a Dutch lake.

Never since the days of Athens has a country risen so rapidly to the highest place in wealth, in art, and in science, as did Holland during her great struggle with Spain. Holland fought for existence and grew rich at the same time, while Spain became exhausted and bankrupt during her struggle for domination. Amsterdam became the financial capital of Northern Europe, and Leyden the home of the most advanced learning, while the Dutch painters acquired that supremacy in art which had formerly belonged to the Italian masters.

The last phase of the religious struggle, brought on by the belated bigotry of Louis XIV. and James II., saw Holland assume for a moment the leading position among the nations of Europe; for it led to the Revolution which seated William of Orange on the English throne, from which he directed that Grand Alliance that, after his death, humbled the power of France. In addition to this, it filled Holland with Huguenot refugees, who lent their arms against their intolerant country, and whose numbers and industry added to the population and wealth of Amsterdam.

The number of Huguenots who left France has never been conclusively established; but few historians estimate it to have been less than a hundred thousand, while some place it at more than half a million. We must be on our guard, therefore, against the popular

misstatement that "the Huguenots came to the Cape." The few hundreds who came to South Africa represent but a very small portion of the great multitude of her sons whom France in her folly drove into exile. We may find their descendants in Switzerland, in Holland, in England, and in Ireland, where—after helping to win the battle of the Boyne—many of them settled as leaders of the "Orange" party. But especially the Huguenots settled in Brandenburg, where they were eagerly welcomed by the Great Elector, and their descendants contributed not a little to the success of the Prussian arms; so much so that in Moltke's army, which took Paris in 1871, more than three hundred officers claimed to have Huguenot blood in their veins. Well, indeed, did France learn to her cost that "like arrows in the hand of a giant, so are the children of those cast out."

Yet, if the number of Huguenots who came to South Africa were small, we must not be led to underrate their importance. In the first place, all religious exiles are to some degree picked men; it is much easier for the base or the vacillating to make a false and insincere submission than to sacrifice home and fortune for the uncertainties of a wandering existence. And, in the second place, we may well doubt if Holland could ever have spared the population necessary for the establishment of a real Colony in the place of the provision station of the Cape. Lack of men prevented the Dutch from deriving any advantages from the discoveries of Tasman and Van Diemen; Australia and New Zealand were left unoccupied for the use of the English who should come a century later. Dutchmen, at this time, were too valuable to be spared; they were wanted as merchants, and they were wanted as sailors. Even the garrisons of Dutch possessions were filled by foreigners from all the nations of the North Sea and the Baltic.

When, therefore, Simon van der Stel objected to the coming of the Huguenots as interfering with his hopes of a purely Dutch settlement, he was fighting against forces which were too strong for him. It has been, we may almost say, the general rule that the new countries of the world are not to be peopled by unmixed populations from any one European nation. Australia and New Zealand appear up to now to have been an exception; but the United States, Canada and South America, all represent exceedingly mixed populations, and there is every sign that South Africa is to follow suit. Its future white inhabitants will not be Dutch, nor English, nor even a combination of both; their numbers already include a daily increasing proportion of Germans, Scandinavians and Jews, and it is easy to anticipate circumstances that may accelerate the increased proportion of these cosmopolitan elements.

To understand the events of the Eighteenth Century at the Cape we must again study the course of European affairs. The victories of Marlborough had placed all power in the hands of the Grand Alliance. England and Holland, though no longer under one king, were firmly united in a defensive alliance, and, at sea, they combined to give laws to the world. To the fleets of England on their

way to India was accorded the treatment of "the most favoured nation," and the steady increase of English shipping in Table Bay was the sign of the growth of the British power in India, which, under Clive and Warren Hastings, was developing into actual domination. Strangely enough, the same period witnessed a continual diminution of the power and energy of Holland. Many causes have been assigned for this decline of the nation which had led the way in commerce and discovery: the excessive accumulation of wealth, which brought the rate of interest down to 2 per cent., the steady profits of the Java trade, which removed the inducement to find new markets, and the gradual introduction of steam-driven machinery into England, which made manufacture depend upon coal supply. But Captain Mahan has drawn attention to the very interesting theory that Holland suffered from the excessive security insured by the permanent alliance with England. Naval power is expensive, and will only be maintained by the permanent need of self-defence; but, while the two maritime nations were allied, Holland could safely neglect her fleet and spend money on the fortifications which seemed necessary as a protection against her military neighbours.

The main facts, however, are beyond dispute: the supremacy over the Indian Ocean, which had been wielded by Portugal in the 16th century, and by Holland in the 17th, had, by the 18th century, passed entirely to England. Holland was allied to England; but in naval affairs they were no longer united as equals. The use of Table Bay was accorded to British squadrons by their allies; but it had become almost a necessity to the existence of the new Indian Empire, and we can see that any change in Europe that broke the alliance would necessitate the seizure of Cape Town by England. Thus we see the world-forces which shaped the destiny of South Africa and determined the course of later events.

While Holland continued to be a centre of learning and refinement, her internal politics became very unattractive to the student of history. The long contest between the "Orange" party of the Stadholder and the orthodox Calvinists and the "Patriot" party of the Amsterdam politician and the advocates of popular government, may not be interesting in itself; but it bears very directly upon South African history. The "Orange" party rested upon the support of England and Prussia, while their opponents received perpetual encouragement from France. Now the last twenty years of the Eighteenth Century saw a French garrison landed at Table Bay by Admiral Suffren, and later on an English force came to occupy the Colony by the authority of the Prince of Orange. Thus we may see that the future of the country depended upon France or upon England, in accordance with the struggle of domestic parties in the Netherlands.

In all history we shall find no greater paradox than the position of the absolute Bourbon kings, posing as supporters of popular rights in Holland and America. Yet, while her own Government represented all that was worst in feudalism and in arbitrary rule, the France

of Voltaire and Rousseau was the exponent of the new ideas which affected every corner of the civilised world, and which—among other effects—changed the whole course of South African history. Whether we look at the village Republics of Swellendam and Graaff-Reinet, with their "National Assemblies," in imitation of Paris, or at the early missionaries, Van der Kemp and Philip, with their assertion of the innate equality of black and white men, or at the work of Clarkson and Wilberforce in opposing slavery—we cannot escape from the permeating influence of Rousseau. Sometimes Rousseau was followed intentionally by democrats, sometimes he was followed unconsciously by philanthropists, sometimes his thoughts found their way into the mouths of preachers who would have repudiated such origin with uncompromising vehemence: but everywhere it was Rousseau. "The Law of Nature," "the Rights of Man," "the Social Contract"—all the noble sentiments or idle catch-words which, for good or for evil, spread throughout the world—all came, in the first place, from Rousseau.

This, then, is a strange and puzzling fact: Fairbairn, Philip, Lord Glenelg, and all the missionaries and philanthropists who hounded the Republican Voortrekkers out of the Colony, derived their ideas from the same ultimate influence in human thought which inspired these Voortrekkers to assert their right to independence and self-government.

To turn from the world of ideas to that of material forces, we find that South African history demands a thorough knowledge of the chief events in the Revolutionary and Napoleonic wars. In those wars the combatants varied, every nation in Europe fighting in turn, and sometimes all nations fighting at once; but, with all these changes, the two protagonists never laid aside their parts. On the one side was always England, and on the other France. Between these nations it was a life and death srtuggle; and into that struggle South Africa was drawn by the overmastering force of events. Other Dutch Colonies were occupied by the British during the war, and the most valuable, from a commercial standpoint, were restored when peace at last came back to Europe; but the Cape was a vital strategic position, and on its fate depended that of India, and, perhaps, even of Australia.

The first occupation by the British was welcome in many respects as terminating the unpopular rule of the company; but the second has often been spoken of with regret by Colonial writers, for it put an end to the very excellent rule established by the Batavian Republic. Yet this regret is based on a strange ignorance of European history. Within a few months of the landing of Sir David Baird, the Batavian Republic itself had ceased to exist in Holland. It had subsisted on the support of France, and Napoleon, with his strange dynastic mania, determined to carve out a kingdom for his brother Louis. Thus it was only by a few months that the Cape escaped the rule of the Bonapartes, the most blighting despotism recorded in modern history.

To readers of Captain Mahan it will come as no surprise that British movements at the Cape were directly dependent on the Naval War in European seas. Thus Lord Howe's "glorious 1st June" was the prelude to the departure of Admiral Elphinstone, while Sir Hume Popham's expedition may be regarded as one of the earliest results of Trafalgar.

The Congress of Vienna and the final settlement of Europe after Waterloo, have to be mentioned in connection with South African history; for by the new order of affairs British dominion was recognised. This settlement cannot possibly be judged or understood in sections. The treaty was a human arrangement full of human errors; the Austrian rule in Italy was destined to fall after fifty years of conspiracy and bloodshed, the coupling of Norway and Sweden was destined to be undone peacefully after ninety years of friction. One crime was perpetrated and remains a monument of international wrong-doing; the fetters of Poland were more firmly rivetted by the joint Governments of Austria, Prussia and Russia. Yet, for all this, the settlement was a genuine attempt to secure the tranquility of Europe; and England in particular can claim to have come out of the transaction with clean hands.

In leading and financing the European resistance to Napoleon, England had added six hundred millions to her public debt; while France, the aggressor, had made war pay for itself by the plunder of the vanquished. It was now in the power of Britain to recoup herself by the annexation of all profitable over-sea dependencies. Instead of this, we find that practically nearly all French Colonies were restored, while Holland recovered the East Indies, her only *revenue-producing* dominions, while the Cape, with all the involved expenditure, was retained by England for its strategic importance.

Nor was this all. An attempt was to be made to set up a new power in Europe. Holland and Belgium were to be erected into a new kingdom of the Netherlands for England's old ally, the Prince of Orange. To enable him to fortify his new kingdom a subsidy of several millions was granted him by the English Government, whose rule in South Africa he at the same time recognised. This transaction has been sarcastically described as the sale of his South African subjects by the new king for so many pounds a head. If sale it was, the terms were far more complimentary to the Colonists than is commonly supposed. For each Colonist with whom the king parted he received more than a hundred pounds sterling and more than two hundred live and industrious Belgian subjects. What higher estimate could the South Africans desire?

But enough has been said, in the course of one paper, to emphasise the assertion that Colonial history cannot be intelligently studied in a water-tight compartment; and from this statement we may proceed to enunciate our belief that Cape History, which is inextricably interwoven with the great web of human affairs, may be made the focus of a system of instruction which shall direct the minds of students towards the most valued treasures of historical knowledge.

5.—PARENTAL DEGENERACY IN EDUCATION.

By H. Bryan, M.A.

6.—THE TEACHING OF MODERN LANGUAGES.

By Mrs. Denby.

7.—PHILOLOGY.

By Miss Moore.

8.—THE BANTU JEWS OF THE ZOUTPANSBERG.

By Rev. H. A. Junod.

9—CONTRASTS BETWEEN EDUCATION AT HOME AND IN SOUTH AFRICA.

By Rev. T. G. Vyvyan, M.A.

10—ENVIRONMENT AND PROGRESS.

By Rev. J. Stalker, M.A.

II.—THE FORMATION OF NATIVE TRIBES.

By James Stewart, J.P.

12—SCHOOL EDUCATION IN SOUTH AFRICA DURING THE YEAR 1905-6.

By Hobart Houghton.

13—THE ADVENT OF THE IMPERIAL BANKS IN SOUTH AFRICA.

By J. R. K. Barker, A. Inst. Bankers.

14—THE CIRCLE IN SOUTH AFRICAN MYTH.

By Prof. E. H. L. Schwarz, F.G.S., A.R.C.S.

(Illustrated with Lantern Slides.)

[Abstract.]

The Tikoe of the Bushman is a rounded stone bored through the middle. The usual size is about five inches in diameter, and never exceeds seven inches; very small ones are occasionally found. The common form is nearly spherical, sometimes slightly cone-shaped, and more rarely disc-shaped. The shaping and centering is usually fairly accurate, but irregular ones are found on the Cape Flats, and, of course, if the stone has been used for other purposes than that for which it was made, such as paint or coffee grinders, the once regular stone may be worn down to any shape. The commonly accepted theory as to the use of the Tikoe is that it was fastened to the centre of the Kibe, or digging stick, and helped to give impetus to the light instrument.* Upholders of this theory, however, fail to account for the small Tikoes, or the flat disc-shaped ones; the former are certainly miniatures of the larger ones, and were probably worn as an ornament or charm, but why imitate the domestic make-weight for such a purpose? In the manner in which they are now found, I am of an opinion that they were not used at all as personal belongings, but were placed at certain spots to indicate boundaries. Mr. Peringuey, whose knowledge of the South African stone-implements is unrivalled, has long tried to prove his contention that the small stone pillars† occasionally unearthed were used for this purpose. In response to Mr. Peringuey's inquiry, Dr. Theo. Hahn wrote that is was well known to him that the Bushman tribes occupy certain territories; for instance, in Great Namaqualand, the tribe of the Obanin on the Lower Fish River; that of the Gamin and the Geinin north-east of Angra Pequena; that of the Hei-guis between lat. 26°-28° S., and about long. 20°-22°; further, that of the Gabe and Ai Bushmen, between Gobabis and Kaitses. In all these cases the land-marks are certain sand-dunes, hills, kopjes, periodical rivers, vleis, springs, and also trees, and in one instance, a grave. That the above-named Bushmen have not changed their abode since the commencement of this century can be conclusively proved.§ I have found the Tikoes so abundantly in the south of the Colony that of late years I neglected to pick them up when I saw them; but the distribution of these stones, sufficiently heavy to seriously inconvenience the small Bushmen, suggested to me independently that they were used to mark boundaries, and were thus scattered up and down the land to mark the limits of the family hunting grounds.

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* E. J. Dunn, Trans. S.A. Phil. Soc., Vol. II., 1880, p. 22.

† Several of these pillars or mullers were illustrated in a paper by Dr. Schönland, published in the Records of the Albany Museum, Vol. II. Part I., 1907.

§ Min. Proc. XVI., Trans. S.A., Phil. Soc., Vol. IX, part I., 1895.

In a recent paper to the Philosophical Society, Mr. Peringuey establishes that the holed stones were certainly used in some instances as make-weights for the kibis, but the fact remains that the Bushmen to-day find it easier to dig without the Tikoe, though these are to be found ready to hand almost everywhere.

Holed stones occur over the whole globe. They are especially common in India, where every village has a familiar one, to which people repair when they wish to transact some serious business or to swear an oath; placing their fingers in the hole, they bind themselves with an inviolable bond. Mr. Rivett Carnac calls attention to the whole discs and polished balls found at Hirsarlik, which are precisely similar to those found amid ancient Indian remains in the Falegarh district of upper Bengal.* The work Tikoe means the Strong Hand, and no one who knows of the significance of the hand in the ritualism of primitive people would ever construe the meaning of the phrase to be the literal one of muscular power. The Strong Hand means the Hand of Testimony, and we find the hand depicted in the act of testifying on sculptures from every land. Bryant, in an old book on Mythology, states that holed stones were found throughout Assyria, and he gives the name for them as Titaia, which many authors connect with Titan, the Sun God, the circle being the symbol for the sun. But τιτάινω in Greek means to "draw one's bow," and the Assyrian sun image is shown as an archer with drawn bow emerging from a winged circle. In the illustration of the Assyrian Sun God it will be noticed that the leather kilt of the archer forms a tail to the winged circle, and one can find sculptures in which there is only the circle without the man, or the man's head becomes that of a bird, and we gradually lead up to the idea of Venus' dove, whose symbol is the ring, or circle.

In the Egyptian paintings we find the winged circle flying over many of the figures, and the explanation of this symbol is currently given for the edification of the vulgar, as "the wings of incubation hatching the orb of chaos." Sometimes two bulls are depicted butting the orb of chaos to liberate the newly-hatched universe. These, however, are deliberate sophisms meant to mislead, and the true nature of the circle as a circle is shown by the attendant uræi, or asps, in the Sun of Thebes. Wherever a circle is a sacred circle, it is marked by having a serpent connected with it in some way; thus, if the priests see something holy in the curvature of a bull's horns, they show that the curvature is that of the sacred circle by depicting a small serpent rising from the bull's forehead.

On one of the Egyptian monuments there is a picture of the hawk god very like the soap-stone birds from the Zimbabwe ruins, surmounted by the sacred circle, and opposite sits a lady with the so-called feather in her cap, the circle and feather in reality standing in the same relation as the holed stone and gnomon in the men-an-tol, and here also we have a second gnomon which both are worshipping.

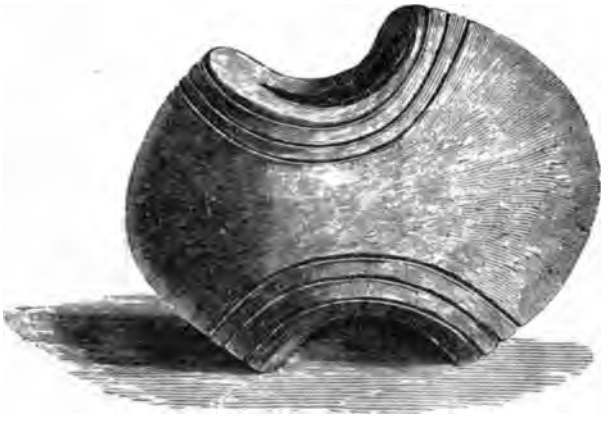
* Journal Asiatic Soc., Bengal, XLIX., I., p. 127.

The lady holds in her hand the symbol of life, the *crux ansata*, which, again, is the circle and gnomon in juxtaposition.

In Peru we find holed stones with six rays sometimes, but rarely five. I believe five rays were made under a mistake, for when these stones were imitated by baked clay, the pottery stars always had six rays. Equally carved in hard Andean lava we find associated with the Peruvian holed stones mealie cobs. In the Old World fir-cones take the place of mealie cobs, and we find many Assyrian and other monuments in which there are depicted dragons or gods offering in one hand a fir-cone, and in the other a circle or symbol of equivalent meaning, such as a bag. These fir-cones, or mealie cobs, I believe, are represented in South Africa by the stone mullers sometimes found associated with the holed stones.

One of my Tikoes, which I found at Karroo Poort, shows distinct cuts on one side, and although they are slight, yet they amount to the sabbatical number of seven. In a cave some considerable way to the north of this, but practically in the same range of mountains, I found a circle with seven rays radiating from it; the coincidence became more marked on finding a triple circle with twenty-one rays. I do not wish to press these facts yet into any theory, but the coincidence, I think, is sufficiently striking to be worth putting on record. At any rate, it establishes that the Tikoe was a circle, and was not regarded as a make-weight, and at the same time it proves that the current belief that the Bushmen had very dim notions of figures above the number three is erroneous, for the paint with which these circles are drawn is of the same age as that with which the other characteristic paintings were made. The cave is on the farm Groenfontein, near the village of Nieuwoudville, between Calvinia and Vanrynsdorp.

Coming now to the holed stones in Europe, we find them set up everywhere. One of the best is at Madron, in Cornwall, which



Tikoe found in Stone Circle at Broomend, Inverurie, Scotland.

Sir Norman Lockyer calls the men-an-tol. It is very complete, and has two attendant pillars or gnomons. Sir Norman's opinion of these holed stones is that they were used for sighting the summer solstice; the fact that the gnomons effectually block up the line of sight does not seem to cause him to have a suspicion of doubt as to the correctness of this view. Near by, at Tregaseal, there is another gnomon, or long stone, and at the foot of it a whole nest of holed stones, small ones, this time, like our Tikoes, and I imagine that Sir Norman would consider these as early attempts of the ancient Britons at making opera-glasses.

In all these circles the disc is upright, but the same idea is conveyed by a recumbent circle, examples of which occur in the Greek temples, and thus one is led to connect the holy wells and clefts with this same worship of the circle.

In an almost inaccessible part of Burmah there is a remarkable temple built on a boulder which balances on the edge of a cliff. Legend tells how this boulder, which is not a rocking-stone, in days of greater piety used to float free above the summit. There are those who argue that even now a fine thread can be drawn between the boulder and the rock. The sacredness of the boulder, however, which caused the temple to be built, is a rounded segregation on the side looking over the valley, which produces on the surface of the stone the holy circle—Siva's eye, watching over the world. General Forlong, who worked his way through almost impenetrable forest to the spot, says that his followers no sooner came near the place than everyone, believers and unbelievers alike, began fishing for treasure which the devout had thrown down the many fissures hereabout, with long bamboos having wax fastened to the end. The General states that his party was unsuccessful, but he was told that often jewels of very great value could thus be recovered. The whole cliff is sacred on account, firstly, of the Sivaic eye in the boulder, secondly, on account of the many fissures around, and the temple is shaped like a gnomon capping the eye, capping the fissures, in the same sense as the gnomon caps the oval in the Roman altar, or the stone needle caps the serpent pit at Constantinople.

We arrive, then, from a consideration of mystic symbols all over the world, at the conclusion that primitive people saw in the circle, pit or crevice, some divine meaning, but concurrently with these there was always a hand, gnomon, pillar or tree which completed the sacred couple. Let us apply these facts, learned from comparative religion, to the great question of the Zimbabwe ruins. The chief temple contains a solid masonry gnomon. When the British Association visited South Africa, we learned from Dr. McIver that this gnomon was of no significance precisely, because there were no signs of the complementary circle to be found; small gnomons are frequently unearthed, but nothing of the nature of a holed stone. If Dr. McIver had not been in such a hurry, or if the explorers of the great Zimbabwe had had a knowledge of comparative religion, they would have seen that the whole reason for the temple being in the position it is, is

the crevice cleft in the rock up which the worshippers had to climb to reach the sacred edifice. This crack is one of the most extraordinary in the world, and to people skilled in nature worship it would immediately suggest a place of great sanctity. With the gnomon standing erect at the top of the crevice the full symbolism of nature worship is fulfilled, and the consanguinity of that cult to that for which the Kyaitligo Paya in Burmah was built stands revealed. The builders of the Zimbabwe were barbaric, and could not carve and gild as the Burmese could, but the enormous labour and the care with which they cut the stones, carried them up the sacred staircase in the cleft and pieced them together on top, shows a vitality in the belief as great as that under which the elaborate carved temple in Burmah was built. The resemblances of the Great Zimbabwe to the Kyaitligo Paya is not restricted to the crevice and gnomon alone, but we have also in both cases the poised boulder, which, in mystic language, would represent the orb of chaos, or the seed of the lotus.

15—THE FUNCTION OF ATHLETICS IN EDUCATION.

By A. S. Langley, B.A.

16—THE ORIGIN OF HOSPITALS.

By J. de Fenton, F.R.A.S., F.C.I.S.

17—SOME UNDERLYING EDUCATIONAL AIMS IN SOUTH AFRICA.

By W. E. C. Clarke, M.A.

Amidst the variety and conflict of interests that tends to sunder and keep apart the different States of this sub-continent, it is pleasing to know that Education is a field in which all sections can find common ground and recognise common purposes and common difficulties.

This short paper does not pretend to deal with all these points, but only to mention a few that have obtruded themselves on the attention of the writer during moments of leisure, amid the rush of the everyday detail of educational administration. There has been much legislative activity within recent years, in all the colonies, in the direction of devising an organised system to supersede the arrangements which, in disconnected and tentative fashion, had come into being, or been provisionally recognised, to meet the urgency of a common want. Throughout the whole of South Africa, it may now be said, that elementary education, and, to a lesser extent, secondary education, have been brought under the sweep of a settled plan; and there is a prospect that before long arrangements will be devised to meet the claims of higher education, in which all the countries of South Africa will be asked to bear a share and take a common interest. All this seems to be making for a systematic control of the machinery of education on common lines, and to be paving the way in one direction, for that political unity and federation, the attainment of which has come sensibly nearer through recent events.

It is not, however, with the formal organisation of education, that I now propose to deal, but rather, with some common aspects of the subject, which codes cannot cover and which those interested in education must feel to be vitally important as affecting the underlying aim of the teacher and the resultant spirit and habit of mind developed in the taught.

I would propose to divide these aspects roughly into the *intellectual*, the *æsthetic*, and—for want of a better name—the *ideal*, and to touch on one or two points under each heading.

The Intellectual.

Under this head, one has to take into account the force of what the ordinary man of the South African world would call "practical considerations," the claim that the form of education, the balance of subjects, and the length of school life must subserve the future career of the young learner from the "practical" and money-earning point of view. The doctrine that "man shall not live by bread alone," has little hold on the majority of people here, and the cult of "Athena Agoraria" (the goddess of the market)—to whom Ruskin says the English people "devote nine-tenths of their property and six-sevenths of their time,"—claims with us frequently an even larger proportion of each. "Is there any money in it?" or "Wat zal ik krij?" is

too frequently the standard of the grown man, not only in regard to matters of direct financial moment, but in regard to almost every occasion where a decision has to be made between the claims of different courses of action or different habits of life. The value of a course of education is determined by the degree of success with which the product of it can amass the greatest quantity of material wealth in the shortest possible time. No doubt, there was a period in the old countries of Europe, when a course of education that in itself had the main purpose of intellectual equipment of the highest kind, was sometimes made subservient to success from a merely material standpoint, and when there was much truth in the gibe that "the advantages of a classical education were, that it would enable you to despise your fellow-man, and to attain positions of considerable emolument." But it cannot be said that there was much danger of classical study ever leading to considerable emolument in South Africa: Greek is already relegated to the few, and Latin stands in some peril of being made "optional," to some subject of more readily discernible profit. The difficulty throughout in this country has been to arrive at any settled agreement as to what constitutes a satisfactory intellectual equipment for life. Several factors have contributed to this. The existence of a number of spoken languages with their direct practical advantages has disguised the educational fact that a man may be able to hold converse in their mother tongue with people of several nationalities, and yet be a totally illiterate person,—that is, he may possess but a limited vocabulary in any and fail to find pleasure in the recognised literature of even one.

Again, towards this instability of standard estimate, has contributed the fact that so little weight in the determination has proceeded from the fixed population in South Africa. The result has been that each new nostrum produced in the intellectual or ducational world elsewhere, has been exploited here, with more enthusiasm than discretion, and has wrought its destruction through excess, some time after its crudeness has been exposed in more settled communities. Notwithstanding the sad lessons of the past, it would seem that the welcome given to each new fad is in proportion to the clamour and assurance with which it is urged, and it is extraordinary how ready is the acceptance of any theory that claims to make for the lightening of mental effort in the learner, and the avoidance of the horror of examinations; and all this just as if the world had not learnt that nothing worth winning can be won—intellectually or otherwise—without hard effort. Various proposals have been offered as to what constitutes a title to the name of "cultured." Macaulay, in his usual extreme fashion, would restrict it to "the man who can read his Plato with his toes on the fender," but the apparently humbler claim for "one who knows something of everything and everything of something" seems to offer the more suitable aim in this country where something of many things is too frequently attained, but where thoroughness of any kind is so rare. The spheres of Mathematics and Science, while demanding intel-

lectuality of the highest order, have here, as a rule, an essentially practical bent given to them, and comparatively few are encouraged to find in their pursuit intellectual pleasure in leisure time. There is one field of Science, however, where the conditions of this country offer special facilities and attractions to the ordinary man—I mean Astronomy. Our clear skies and pure atmosphere are surely similar to those of the Eastern countries, where this Science had its birth. It may be said in objection that we lack here the leisured class, who have time to devote to such studies; but let me say, that it is a complete mistake to imagine that great results are achieved only by those who have plenty of time. In the sphere of Astronomy one of the most distinguished members of this Society won his name by the devotion of leisure hours snatched from the drudgery of the teaching profession, and the recognition of his work by the Royal Astronomical Society, one morning startled his friends, who had regarded him as merely amusing himself with the harmless fad of star-gazing.

I would appeal especially, however, for what lies within the reach of all, the cultivation of a taste for reading what is best. The next stage, original production, must for some, at any rate, follow later. Surely, one of the requisites for the production of the best in literature as well as in art—a period of struggle and sacrifice—we have had here in full measure. Why is it that some of the most vigorous and original writings of the present day come from America? Her independent civilization is not much older than ours, although her numbers are greater, and her constituent races, though in different proportion, are the same as our own. So much talk about languages, and so little done to cultivate taste in or love for literature—"the acquainting ourselves with the best that has been known and said" in a language! So little produced, and yet some of that little so excellent that one feels that the possibility is with us. (May I here express the regret, which I am sure many share, that the pen of one who some years ago touched with her writings the heart-strings of her countrymen, should latterly have been still except in the less worthy field of political controversy?) There is one thing absolutely certain, however, about the culture that I am pleading for,—there is no "money in it"; its reward is something beyond diamonds and rubies; its pleasures grow with the using, and no man can take them from you.

The chief aim, then, in this intellectual aspect of education, is to endeavour to awaken not only a love for reading, but a taste in literature. Let the true test of a book's worth be unceasingly inculcated—if it is not worth reading more than once, it is not worth reading at all. And let our youth be saved from finding their sole pleasure in later life in the flimsy sensationalism of the cheap periodicals, or the "feverish babble" of a Marie Corelli. Will you let them "go and gossip with your housemaid or your stable-boy, when they may talk with kings and queens"?

(2) *The Æsthetic.*

The second aspect to which I would invite attention is the Æsthetic, the aim of arousing and stimulating the appreciation of what is beautiful in nature and in art. First, the neighbourhood in which we live has its distinctive features. It may be the wooded kloofs, and the soft velvety slopes of the hills, with the murmuring stream, parent of music and rhythmical sound; or the towering mountains with their rugged tops and mighty shadows; or, perhaps, the great stretch of veld with its vastness and its mystery, that Nature presents to us. Someone has said that "no race of men which is entirely bred in wild counthry, far from cities, ever enjoys landscape"; and it is undoubtedly true that the sense of contrast is essential to the full apreciation of anything. But, while unbroken familiarity may fail to awaken the sense, it is surely possible by attention to rouse and stimulate it. So much of the natural beauty of this South African land seems to consist in appeal to one as being fresh from the hand of God; whereas in older countries so little can be seen that does not bear some record on its surface of human activity, awakening historical and other associations. It is in this virgin freshness of this country that its chief charm lies; and that is the reason, perhaps, why the South-African-born feels in the hedged fields and trim landscapes of the old countries a sense of artificiality and restraint. There can be no doubt that this vastness and freshness of landscape has its reflex in the freedom and independence of colonial character.

Thus far of the land surface only, but what of the changeful wonder of the skies, if only the attention is once directed to their charm. And the beauty of the trees and the flowers, and the birds —the brilliance of colouring which seems to be the chief feature of all things in a land of sunshine. In this consideration of earth and sky, the practical too often obtrudes itself, to the exclusion of any thought of beauty,—a stretch of upland suggesting merely a proposition in sheep, and a glorious sunset spelling only weather and crops.

Whatever sense and taste—or the lack of these—have been developed in man from his observation of such things, gives character to the works he produces and the new face that he puts upon nature. And here there surely seems to be, in some respects, a grievous falling off from the past. Consider the charm of the old Dutch farm-houses of the Western Province, their solidity and simplicity of architecture, their quaint gables and thatched roofs, nestling among immemorial oaks, and compare them with the conventional type of dwelling that the modern architect has created for later generations—its tin roof, tawdry verandahs and pepperbox ornamentations. Cannot the taste and character of the inmate be read from the form of the home he creates for himself; and does not the contrast suggest some falling away from the strength and simplicity of earlier days? There has been no doubt a recent revival in house architecture, and much is being done in the Cape Peninsula and elsewhere, not only towards

general improvement, but in the direction of a return to the distinctive features of the past. But what of the effect of the bare, featureless, hastily-erected structures that jar upon the sense in so many of the up-country districts, totally out of keeping with the scenerw in which theyare set, and, suggesting only a careless and temporary purpose, and no stability or permanence ?

What, therefore, has to be created in the young, is a taste and a regard for beauty of form in the home and in its setting. In order to develop this, to some extent, I would appeal for more worthy buildings for our schools in the first place. Many of us know the slight care that has been bestowed on these until quite recently. Even where there has been no stint of money, the grim and forbidding structures that have been erected,—the rigid conceptions of the conscientious educationist about his window and floor space, with the medical officer's ventilating appliances writ large over them inside and out—are not such as to attract the young learner, or to stir in him any feeling of respect for great buildings. The reverence due to traditional association cannot be built up except with the lapse of generations, until we feel that in certain precincts, we are "treading on history"; but a nation is bound to suffer, if this appreciation of artisitc structure is not cultivated in her children; and fit objects must be created, where they have not come down from the past. Elaborate expenditure on Town Halls and churches is no doubt good, so far as it goes, but it is better that the buildings in which a great part of the children's life is spent, should be of the noblest and the best. So much may have birth given to it there; the learning imparted bears its share, but the whole surroundings impress their effect unconsciously on the young minds, implanting gradually a respect for what is grand and beautiful in form, and a "divine discontent" with what is unsightly and unworthy, a discontent that will work its result later in the homes they create for themselves.

And it is not only great buildings that I would plead for—no work can be worthier of a stately setting than the training of the young—; but I would appeal as well for spacious grounds, not only room for recreation and sport on the physical side, but space without sense of stint, that may be made beautiful and attractive with trees and flowers. "A nation is only worthy of the soil and the scenes it has inherited, when by all its acts and arts it is making them more lovely for its children."

I am compelled to leave untouched the whole question of music and pass to my next head.

(3) *The Ideal.*

By this term I do not mean to convey the sense of any counsel-of-perfection, but rather the cultivation of a practical standard of corporate life. It is a commonplace that a sense of corporate responsibility raises the level of action of the average individual

member of the body—the saying that "the House of Commons has more good taste than any single member of it," is an extreme statement of the same fact. "An Englishman's word is his bond," is another illustration of how much a generalisation can do to lift the average individual above the line that his own nature might lead him to follow.

The feeling which is to serve for after life must begin in the *esprit de corps*, the standard of the school. In older countries there are traditional standards of honour and good taste, sometimes admirable, sometimes distorted by strange and ludicrous limitations whose origin is lost in the mists of the past. In this country such *esprit de corps* largely remains to be created, and with the experience of older nations to guide us, it may be possible to follow the best and leave aside the errors and the extremes. There is one form of *esprit de corps* that is to be avoided, a spirit that refuses to see any possibility of flaw in its own members, or to recognise the possibility of equal merit or excellence in others. To cultivate this is to foster sheer prejudice, and to destroy the development of all generous feeling. The standard of honour tends to become narrowed down to "playing the game" with the members of the body, and adopting a different measure towards those outside the charmed circle. Such is the spirit that has led to the saying that "if some people got rid of their prejudices they would get rid of their principles." We know too well the type of character that this tends to develop, a character of contemptuous reserve, that is only a subtly-disguised form of self-glorification, and the victim of it carries through life in his bearing towards others an attitude of Pharisaic exclusiveness. The true *esprit de corps* must be based on sympathy or fellow-feeling, the imaginative understanding of the feelings of others. There must be no narrowness or partiality in its texture, and no standard adopted for the treatment of its members that cannot be applied equally to others. A jealousy for the honour of the school must not mean a blindness to its shortcomings, but a corporate determination that no meanness or selfishness shall be tolerated, and that the action of each individual shall be such as will make for raising the general level and adding to the common credit. It must permeate the whole life of the school, work and sport alike, and result in a breadth and generosity of character that will recognise worth and merit wherever met.

General principles are excellent, but it is the concrete example that appeals most readily to the young mind, and hero-worship is probably the most potent factor in developing school ideals. It is well to see then that the objects of this worship are not merely the distinguished scholars or the heroes of the playing-fields, but those who were never known to do a mean thing and whose presence was always a bulwark of strength to the weaker and younger.

This *esprit de corps* of the school widens later into the feeling of patriotism that has in all times and in all ages been honoured by poet and singer as one of the most ennobling of human sentiments.

And in this field the same cautions have to be observed that we have noted in the smaller sphere of the school. In this country of South Africa, the sentiment of patriotism has to be purged from much that tends to narrow and limit it. I shall not be accused of touching on controversial politics if I plead for the cultivation in our young people of a love for South Africa as a whole. The barriers of prejudice as between State and State, and race and race, must be broken down, and a corporate sentiment kindled for the history of this country as a whole, and in relation to the World's history, a pride in the struggles and sacrifices and the victorious deeds of all the races of our people, and an ambition to see that all the energy and devotion once wasted in conflict, shall in the future be united to carry forward this country to higher things than could ever have been achieved in rivalry and disunion. We must see that the narrow view that has warped the minds of more than one section of our people, tending to restrict to one side or the other the right of inheritance in all that has been so dearly bought and built up, shall be done away with, and that the noble sentiment of patriotism shall not be debased, as with the Jews of old, into a barren pride in blood privilege.

It is the training of the girls in particular that much of the success of this work will depend. It is the privilege of the woman to enter with her whole heart into the history she reads, and to inspire her children with a sentiment that moves them, throughout life, more strongly than any other. Let the feeling she inculcates be a true patriotism and not prejudice.

There is a noble passage in Russell Lowell's essay on Democracy with which I will conclude :—

> "The true value of a country must be weighed in scales more delicate than the balance of trade. . . . On a map of the world you may cover Judea with your thumb and Athens with a finger tip, and neither of them figures in the prices current; but they still lord it in the thought and action of every civilised man. . . . Material success is good, but only as the necessary preliminary to greater things. The true measure of a nation's success is the amount that it has contributed to the knowledge, the moral energy, the intellectual happiness, the spiritual hope and consolation of mankind. There is no other, let our candidates flatter us as they may."

APPENDICES.

Appendix I.

SOUTH AFRICA MEDAL AND FUND.

(Raised by Members of the British Association in commemoration of their visit to South Africa in 1905.)

RULES FOR THE AWARD.

I.—Constitution of Committee.

(*a*) The Council of the South African Association for the Advancement of Science shall, annually and within three months after the close of the Annual Session, elect a Committee to be called "the South Africa Medal Committee," on which, as far as possible, every Section of the Association and each Colony of South Africa shall have fair representation.

(*b*) This Committee shall consist of a Chairman and not less than seven members, elected from amongst Council Members; and shall have powers to add to its number additional members, not exceeding one third of the original, selected from members of the Association who are not on its Council.

(*c*) One-third of the members of this Committee shall retire annually by rotation, but shall be eligible for re-election.

II.—Duties.

(*a*) The duties of the Committee shall be to administer the Income of the Fund and to award the Medal, raised in commemoration of the visit of the British Association to South Africa in 1905, in accordance with the resolution of its Council.

(*b*) This resolution reads as follows:—

(1) That, in accordance with the wishes of subscribers, the South Africa Medal Fund be invested in the names of the Trustees appointed by the South African Association for the Advancement of Science;

(2) That the Dies for the Medal be transferred to the Association, to which, in its corporate capacity, the administration of the Fund and the award of the Medal shall be, and is hereby, entrusted, under the conditions specified in the Report of the Medal Committee.

(*c*) The terms of conveyance are as follows:—

(1) That the Fund be devoted to the preparation of a Die for a Medal, to be struck in Bronze, 2½ inches in diameter; and that the balance be invested and the annual income held in trust.


FOR SCIENCE & RESEARCH IN SOUTH AFRICA


IN
COMMEMORATION
OF THE MEETING
IN SOUTH AFRICA
OF THE BRITISH
ASSOCIATION
FOR THE
ADVANCEMENT
OF SCIENCE
1905

(2) That the Medal and income of the Fund be awarded by the South African Association for the Advancement of Science for achievement and promise in scientific research in South Africa.

(3) That, so far as circumstances admit, the award be made annually.

(*d*) The British Association has expressed a desire that the award shall be made only to those persons whose Scientific work is likely to be usefully continued by them in the future.

III.—Awards.

(*a*) Any individual engaged in Scientific research in South Africa shall be eligible to receive the award.

(*b*) The Medal and the available balance of one year's income from the Fund shall be awarded to one candidate only in each year (save in the case of joint research); to any candidate once only; and to no member of the Medal Committee.

(*c*) Nominations for the recipient of the award may be made by any member of the South African Association for the Advancement of Science, and shall be submitted to the Medal Committee not later than six months after the close of the Annual Session.

(*d*) The Medal Committee shall recommend the recipient of the award to the Council, provided the recommendation is carried by the vote of at least a majority of three-fourths of its members, voting verbally or by letter, and submitted to the Council at least one month prior to the Annual Session for confirmation.

(*e*) The award shall be made by the full Council of the South African Association for the Advancement of Science after considering the recommendation of the Medal Committee, provided it is carried by the vote of a majority of its members, given in writing or verbally.

(*f*) The Council shall have the right to withhold the award in any year, and to devote the funds rendered available thereby, in a subsequent award or awards, provided the stipulation contained in the second term of conveyance of the British Association is adhered to.

Nominations for the recipient of the Award addressed to the Assistant General Secretary, South African Association for the Advancement of Science, P.O. Box 1,497, Cape Town, will be received up to and including the 16th January, 1908.

Should a member of the Medal Committee accept nomination for the Award, he will forfeit his seat on the Committee.

Appendix II.

REPORT OF THE ANTHROPOLOGICAL STANDING COMMITTEE FOR 1907.

During their visit in 1905, the British Association discussed in Section H. (Anthropology) certain propositions which were subsequently forwarded to us as recommendations by the Recommendation Committee, British Association. These recommendations included :—

1. The preservation of all records, traditions, legends, etc., of the aboriginal races of South Africa.

2. The promulgation of an authoritative and uniform system of spelling for all geographical, historical, and such like, terms in native languages.

3. The desirability of an education in Anthropology and Ethnography for all officials of the various Native Affairs Departments.

The South African Association, etc., accepted these recommendations, which in fact partly originated from its own members, and decided at a Council Meeting, held in December, 1905, to establish an Anthropological Standing Committee, and requested Sir G. Lagden (Transvaal), Dr. Peringuey, Director S.A. Museum, (Western Province), and Dr. Schönland (Eastern Province), to act as first members of such Committee, with Mr. A. von Dessauer as provisional Honorary Secretary.

As the result of many meetings and much correspondence, the following outlines were adopted for the procedure of the immediate future.

1. To enlist the sympathy and co-operation of all the Colonies and States in South Africa, this being essential for the production of useful, complete and authoritative work.

2. To form Sub-Committees in every State with the support, and under the protection, of the respective Governments.

3. These Sub-Committees to consider and devise means for raising the funds necessary, which will be considerable in view of the magnitude of the problems to be solved.

4. These Sub-Committees to elect one Joint Central Committee with a permanent Secretary.

The difficulties and obstacles met with since its formation by the first tentative Committee were incessant—and often such as not only to delay all progress, but at times to threaten its very existence. It is, however, unnecessary to detail these, now that the immediate future seems to hold out promise of success.

Mr. W. Windham has been good enough to fill the vacancy created by Sir G. Lagden's departure for Europe, and, like his predecessor, is giving much time and warm sympathy towards the